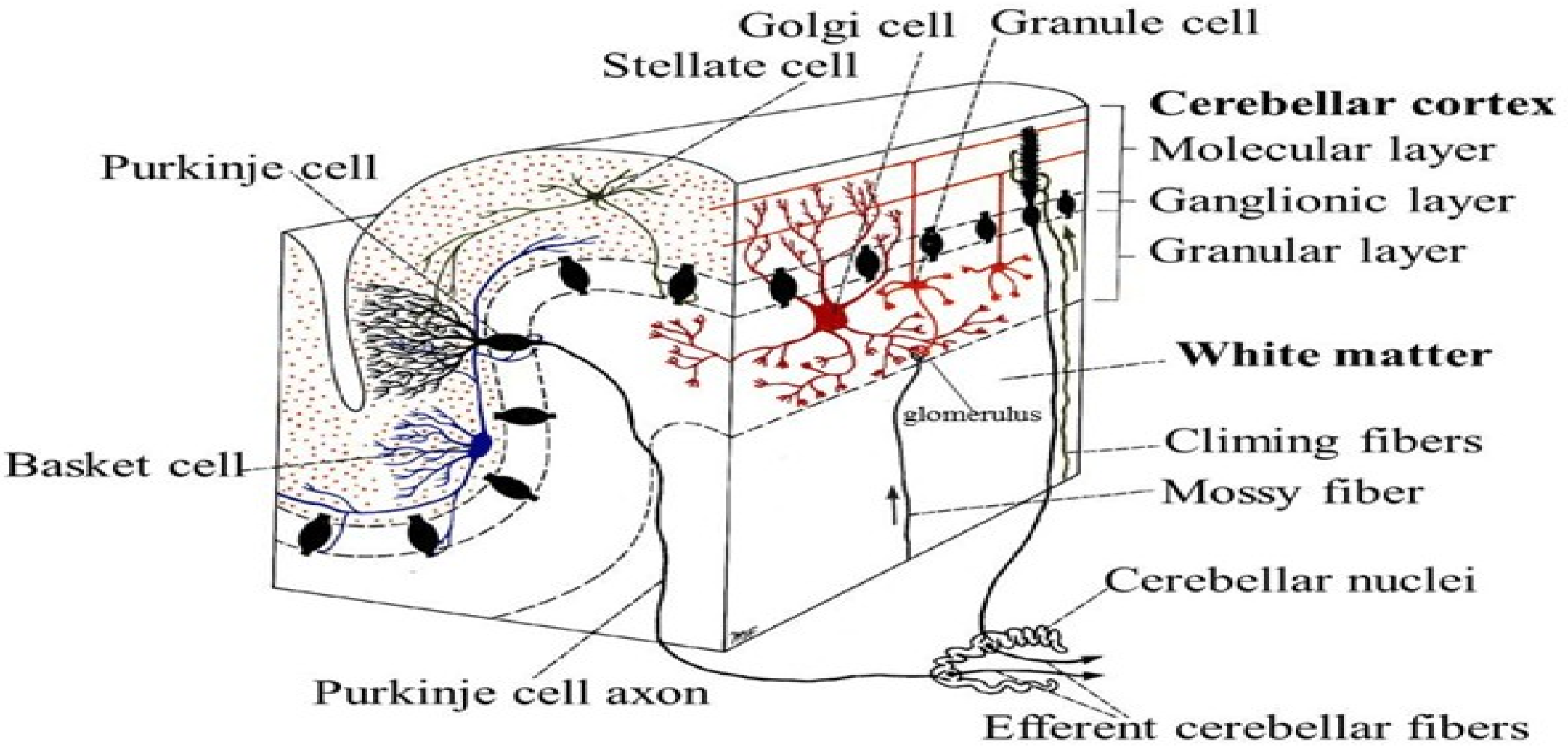
Armed Forces College of Medicine

AFCM

Revision

Dr. Manal Hassan

The cerebellar cortex



Adopted from: R.S.Snell. Clinical and functional histology for medical students, *Little, Brown and Company*, 1984

The cerebellar cortex

Composed of transverse folia.

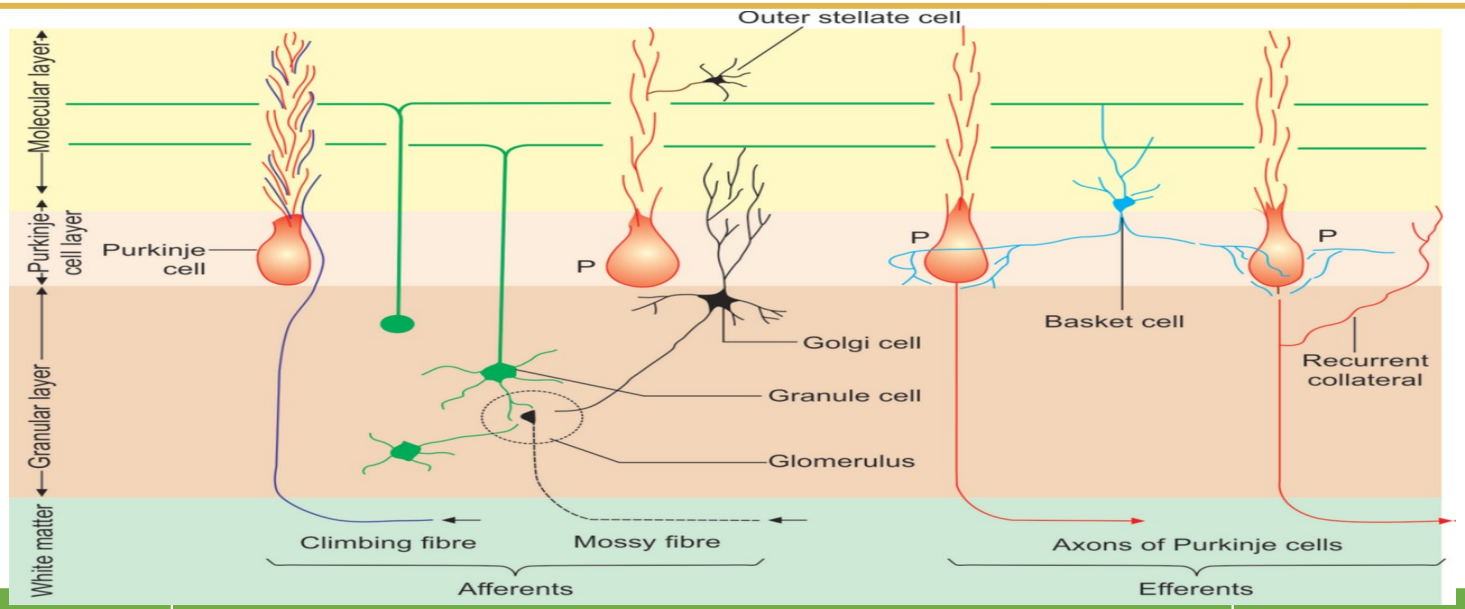
Each folium contains a core of white matter covered by a gray matter.

The cerebellar cortex is formed by 3 layers

Molecular layer	Purkinje cell layer	Granular layer
- Stellate cells - Basket cells	- Purkinje cells	- Granule cells. - Golgi type II cells. - Cerebellar islands (Glomeruli)

Mention the cells and fibers in the Molecular lay

Outer most layer.
2 types of cells:



Basket cells	Stellate cells	
Deep part of the molecular layer	**Superficial** part of the molecular layer	**Site**
Found in the same layer		**Dendrites**
Form basket-like terminal arborizations around purkinje cell bodies	Pass parallel to the surface of the cerebellum, to synapse with the dendrites of purkinje	**Axons**

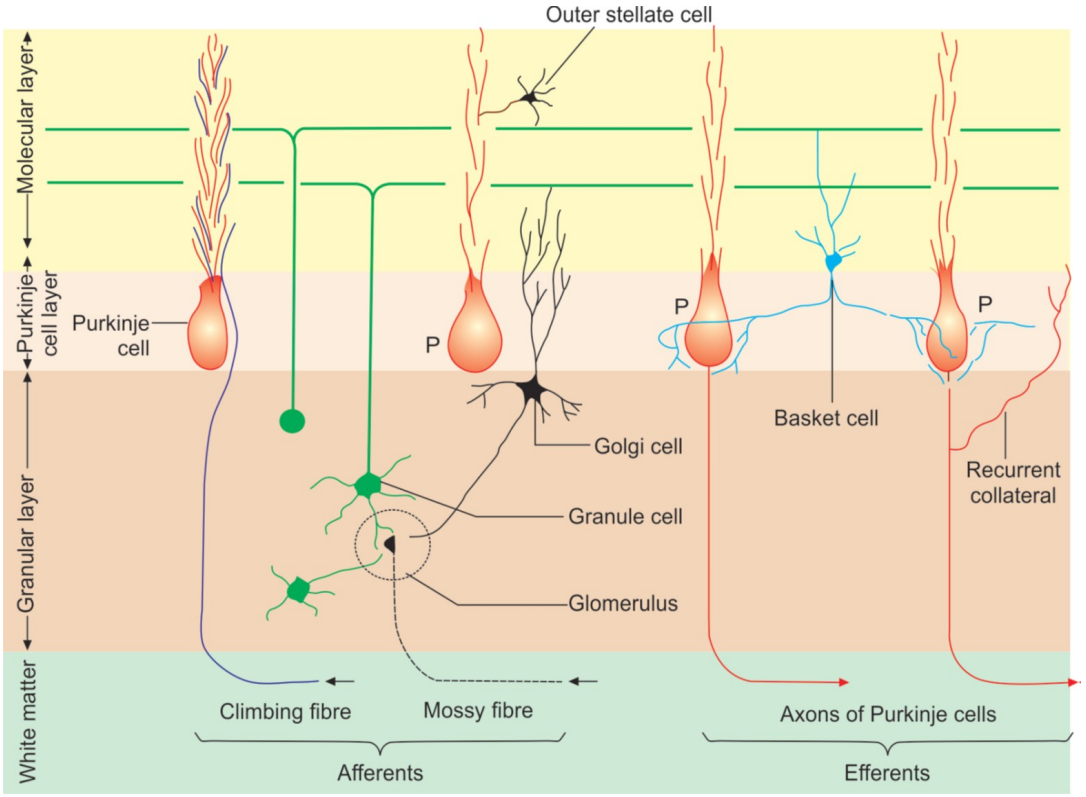
Fibers of the molecular layer:

a) Dendritic arborizations and axons of its own cells.

b) Dendrites of cells in the deeper layers (purkinje cells and golgi type II cells).

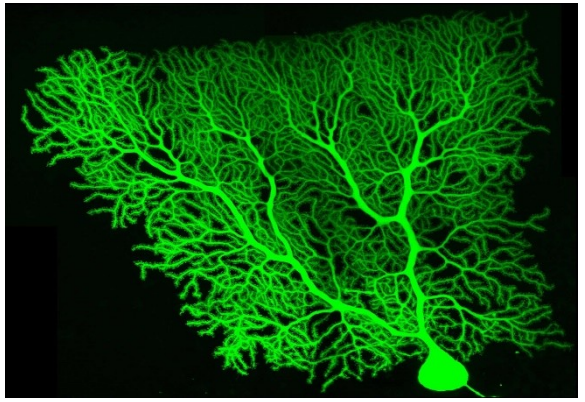
c) **Climbing fibers**, the afferent fibers to the cerebellum.

d) Axons of granule cells which form **parallel fibers** parallel to the long axis of folia.



Purkinje Cell layer

- middle layer of the cerebellar cortex formed of one type of cells (Purkinje cell)
- large cells, arranged uniformly in a **single row** along the upper margin of granular layer.
- **Cell body:** Each cell has a large flask-shaped cell body. It has a vesicular central nucleus and coarse cytoplasmic Nissl's granules.



Dendrites:

- Form a fan-like dendritic tree, at right angles to the long axis of the surface.
- These dendrites branch to give rise to primary, secondary and tertiary branches.
- Primary and secondary branches are smooth, while the tertiary

Purkinje Cell layer

- **Axons:**

- They represent the efferent pathway from the cortex.

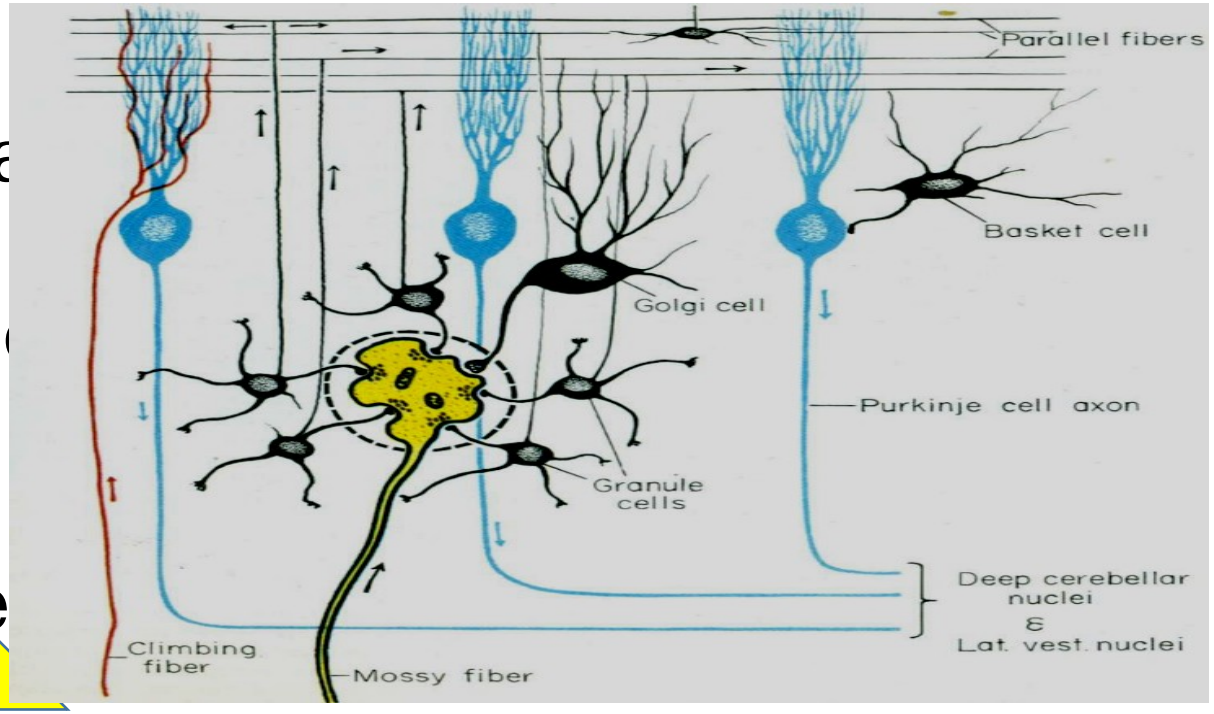
- Myelinated passing through the granular layer and white matter to synapse with deep cerebellar nuclei. (Some axons bypass the deep cerebellar nuclei and leave the cerebellum to reach the vestibular nuclei).
- They give collaterals that synapse with Golgi type II and basket cells.

Granular layer

Cerebellar islands (Glomeruli):

These are irregularly dispersed pa
non cellular areas, composed of a
complex synaptic structure forme
of:

1) Mossy fiber terminal .
2) Dendrites of numerous gra le
cells.
3) Axons of Golgi type II cells



Function:

This structure excites granular cells which in turn excite purkinje cells. Axons of granule cells (unmyelinated fibers), ascend vertically to the molecular layer and synapses with Purkinje cell dendrites.

Granule cells are the only excitatory neurons in the cerebellar cortex.

Quiz

Analyze the connections between the cerebellar island histological structures

Afferent fibers entering the cerebellum from a) Spino-cerebellar tracts, b) Cuneo-cerebellar tract c) Ponto-cerebellar tract d) Vestibulo-cerebellar tract

end as mossy fibers in the cerebellar islands

↓

Synapse with dendrites of the granule cells that send parallel fibers to the molecular layer

↓

Parallel fibers synapse with dendrites of Purkinje cells which give the cerebellar cortex output

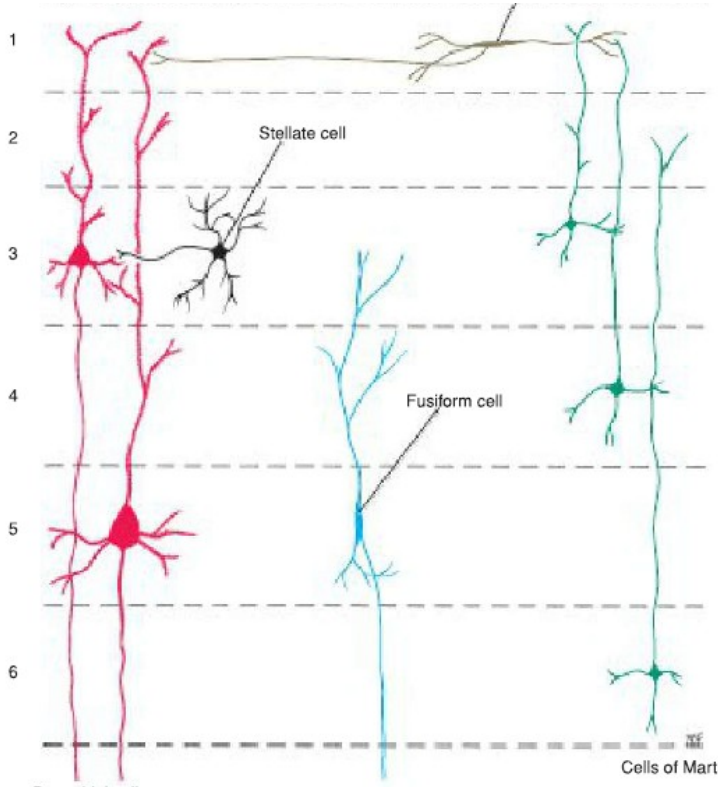
6 Layers of the cerebral cortex

I Molecular layer:

Most superficial

Formed mainly of nerve fibers and cells of Cajal (absent adult brain)

Nerve fibers include dendrites of pyramidal ar fusiform cells and **axons of Martinotti cells**



II External granular layer:

-closely packed granule cells whose dendrites terminat in the molecular layer.- Their axons descend to the dee cortical layers.

III External pyramidal layer:

small and medium sized pyramidal cells

Their dendrites pass to first layer, while their axons enter white matter.

IV Internal granular layer:

closely packed granule cells. whose dendrites terminate in the molecular layer

- Their axons descend to the deep cortical layers.
- It also contains the outer band of Baillarger.

Layers of the cerebral cortex

V Internal pyramidal layer:

Formed of large and giant pyramidal cells. Their axons project to enter the white matter as projection fibres. **In motor area 4 these cells called giant cells of Betz. It gives the corticospinal tract**

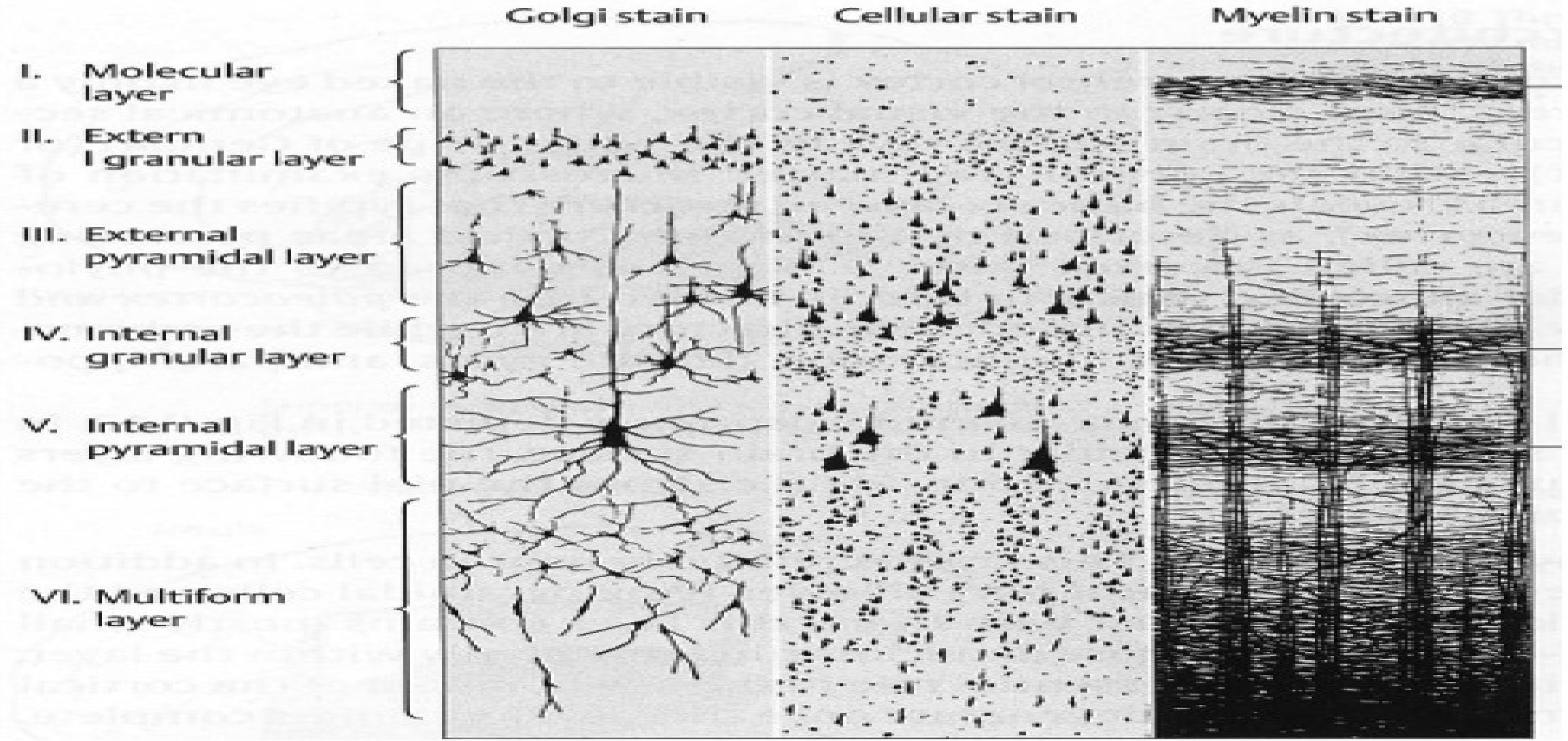
- It also contains the internal band of Baillarger.

6) The multiform layer:

contains fusiform cells.

Their denderites pass to the molecular layer

- Their axons enter the white matter as projection fibres.
- Cells of martinoti whose axons pass up to the molecular layer



http://www.learnneurosurgery.com/uploads/1/6/6/8/16689668/_8909191_orig.png

Differences between sensory and motor cortex

Motor cortex

1) It is the thickest zone in the whole cortex.

2) Large **pyramidal cells** are found in layers III and V ,

giant pyramidal cells (Betz) are seen in the fifth layer.

3) Granule cells are rare or absent.

Sensory cortex

1) It is relatively thinner than motor cortex.

2) It contains closely packed **granule cells**.

3) Pyramidal cells are ill defined.

Quiz

Which of the following fibers is present in the molecular layer of the cerebellum?

a. Mossy fibers
b. Golgi cell axons
c. Parallel fibers
d. Basket cell axons
e. Pyramidal fibers

Quiz

Which of the following fibers share in the formation of cerebellar islands?

a. Climbing fibers
b. Mossy fibers
c. Purkinje fibers
d. Stellate fibers
e. Basket fibers

Quiz

Parallel fibers in the cerebellar cortex arise from which type of neuron?

- A. Basket cell
- B. Golgi cell
- C. Granule cell
- D. Purkinje cell
- E. Stellate cell

Quiz

Which of the following is most likely directly influenced by mossy fiber input?

- A. Basket cells
- B. Deep cerebellar nuclei
- C. Granule cells
- D. Purkinje cells
- E. Stellate cells

Quiz

From which of the following structures do climbing fibers originate?

- A. Cerebral cortex
- B. Inferior olivary nucleus
- C. Pontine nuclei
- D. Spinal cord
- E. Vestibular nucleus

Quiz

Which of the following cell types has an excitatory function?

- A. Basket cell
- B. Golgi cell
- C. Granule cell
- D. Purkinje cell
- E. Stellate cell

Quiz

Which cortical layer contains the neuronal cell bodies of axons in the corticospinal tract?

- A. Layer I
- B. Layer II
- C. Layer III
- D. Layer IV
- E. Layer V

Quiz

Analyze the connections between the cerebellar island histological structures

Afferent fibers entering the cerebellum from a) Spino-cerebellar tracts, b) Cuneo-cerebellar tract c) Ponto-cerebellar tract d) Vestibulo-cerebellar tract

end as mossy fibers in the cerebellar islands

↓

Synapse with dendrites of the granule cells that send parallel fibers to the molecular layer

↓

Parallel fibers synapse with dendrites of Purkinje cells which give the cerebellar cortex output

Cerebral & Cerebellar cortex

Complete:

The cerebellar island is formed of:

1. Mossy fibers
2. Granule cell dendrites
3. Golgi cell axons

The layers of the cerebral cortex are:

1. Molecular layer
2. Outer granular layer
3. Outer pyramidal layer
4. Inner granular layer
5. Inner pyramidal layer
6. Multiform layer

Compare between:

1. **Basket cells** & **Stellate cells**

2. **Golgi type II Cells** & **Granule Cells**

3. **Motor cortex** & **Sensory cortex**

Compare between:

Basket cells & Stellate cells .1

Basket cells	Stellate cells	
Deep part of the molecular layer	Superficial part of the molecular layer	**Site**
Found in the same layer		**Dendrites**
Form basket-like terminal arborizations around purkinje cell bodies. (a single cell makes synapse with many Purkinje cells up to 10 cells)	Pass parallel to the surface of the cerebellum, to synapse with the dendrites of purkinje cells	**Axons**

Quiz

Compare between Golgi type II Cells & Granule Cells .2

Golgi type II Cells	Granule Cells	
Found in the upper parts of the granular layer	Small cells having large rounded nuclei and thin rim of cytoplasm with few Nissl’s bodies	**Cell body**
Extend in all layers of the cortex	Show claw like endings that terminate in the glomerulus	**Dendrites**
End within the cerebellar glomeruli	Their axons ascend to the molecular layer, where they bifurcate to give rise to parallel fibers that synapse with	**Axons**

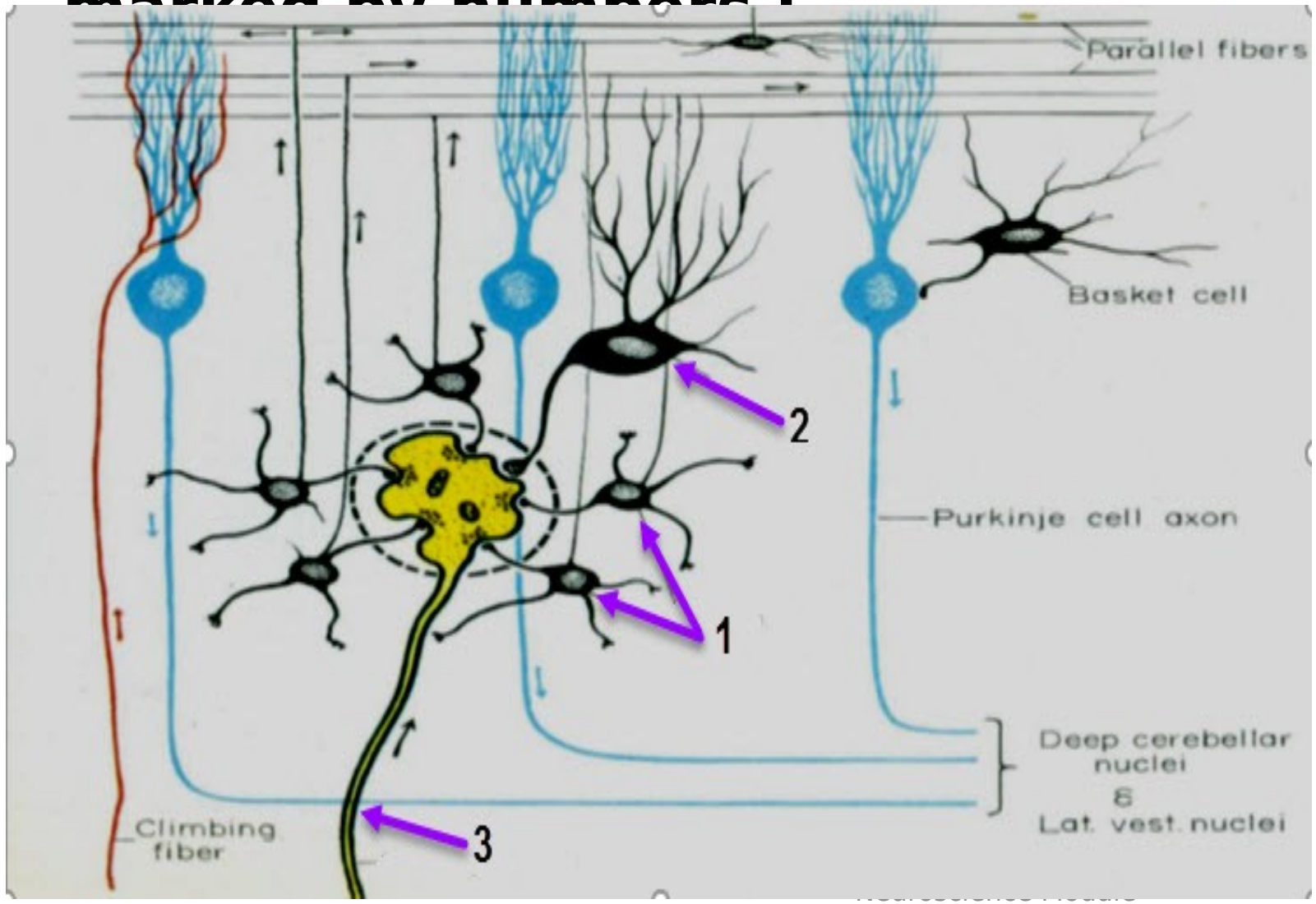
Compare between:

Motor cortex & Sensory cortex .3

Motor cortex	Sensory cortex
1) thickest zone in the whole cortex.	1) relatively thinner than motor cortex.
2) Large **pyramidal cells** are found in layers III and V , while giant pyramidal cells (Betz) are seen in the fifth layer.	2) It contains closely packed **granule** cells.
3) Granule cells are few.	3) Pyramidal cells are ill defined.

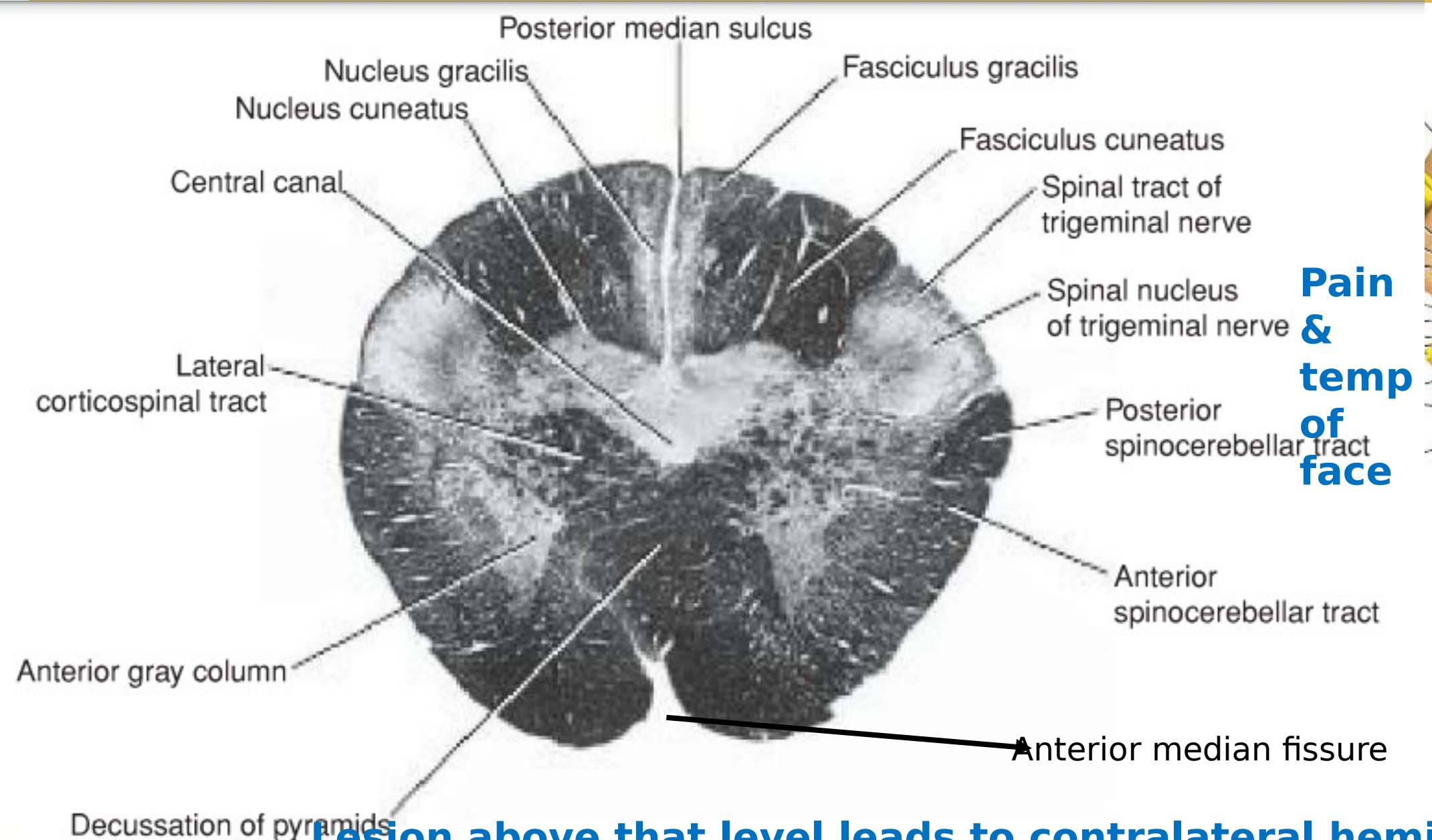
Cerebral & Cerebellar cortex

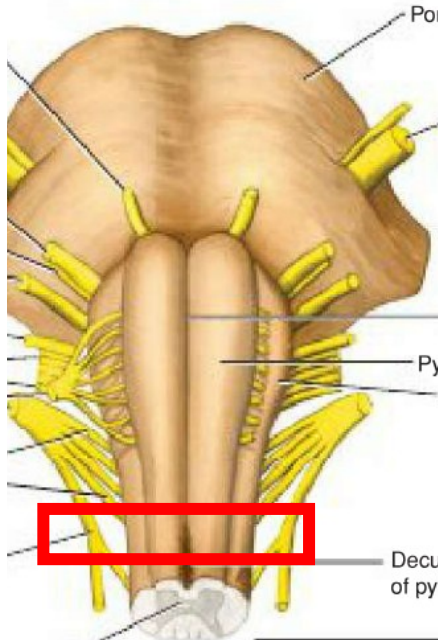
Identify the structure and label the structures marked by numbers :



1. Granule cells
2. Golgi cells
3. Mossy fibers

Closed medulla at level of motor decussation

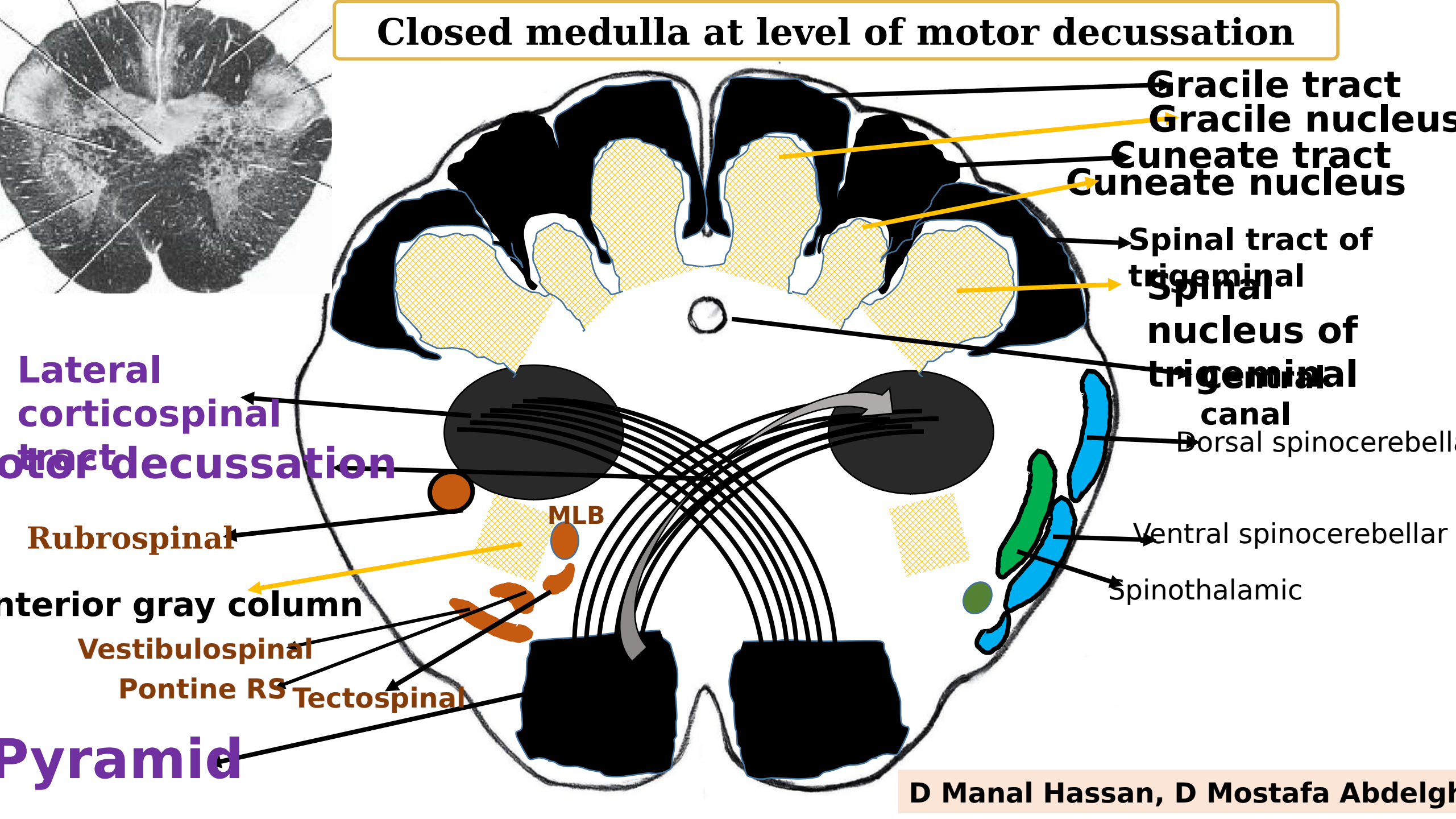




Pain & temp of face

Lesion above that level leads to contralateral hemiparesis

Closed medulla at level of motor decussation



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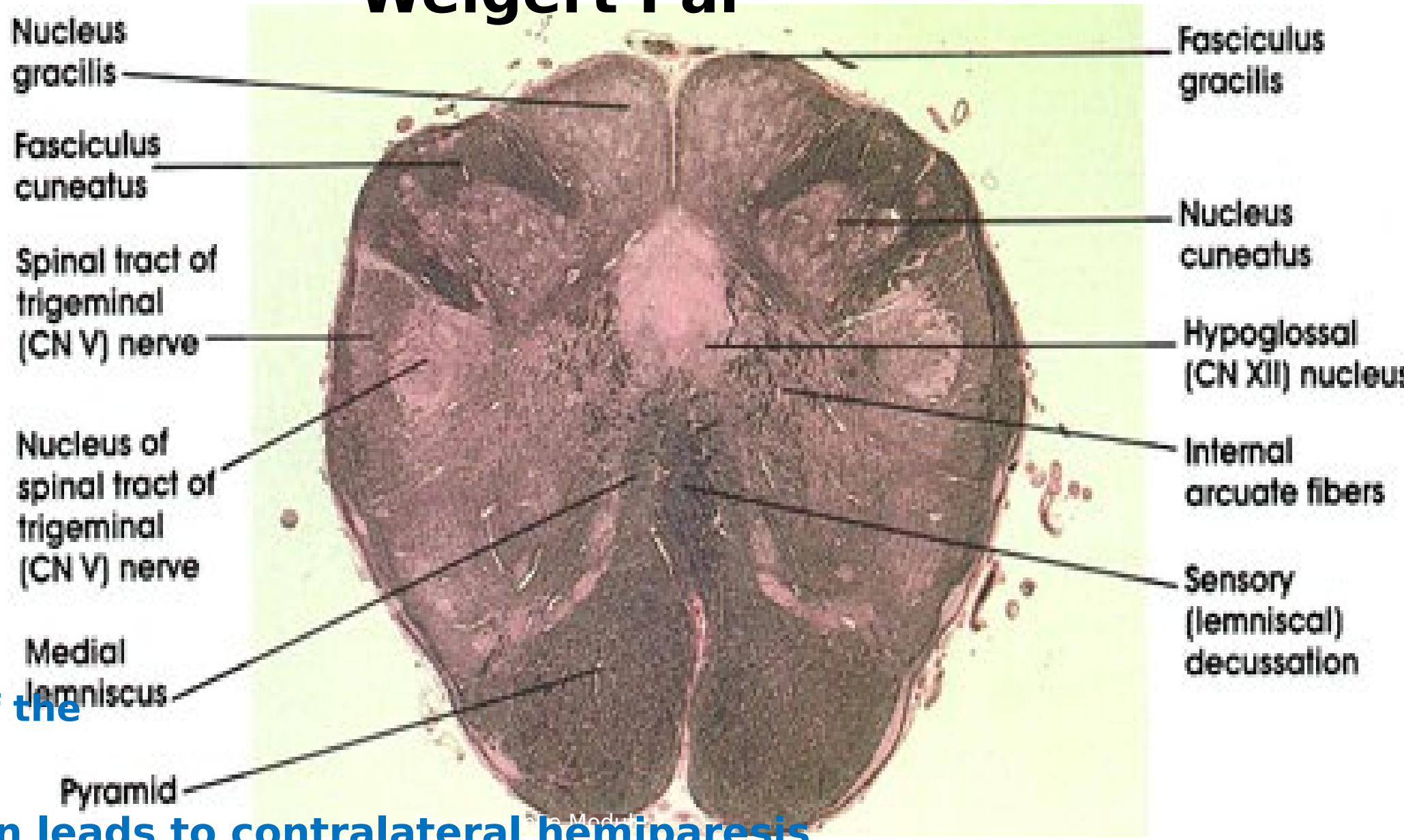
Closed Medulla----- Sensory decussation -- Weigert Pal

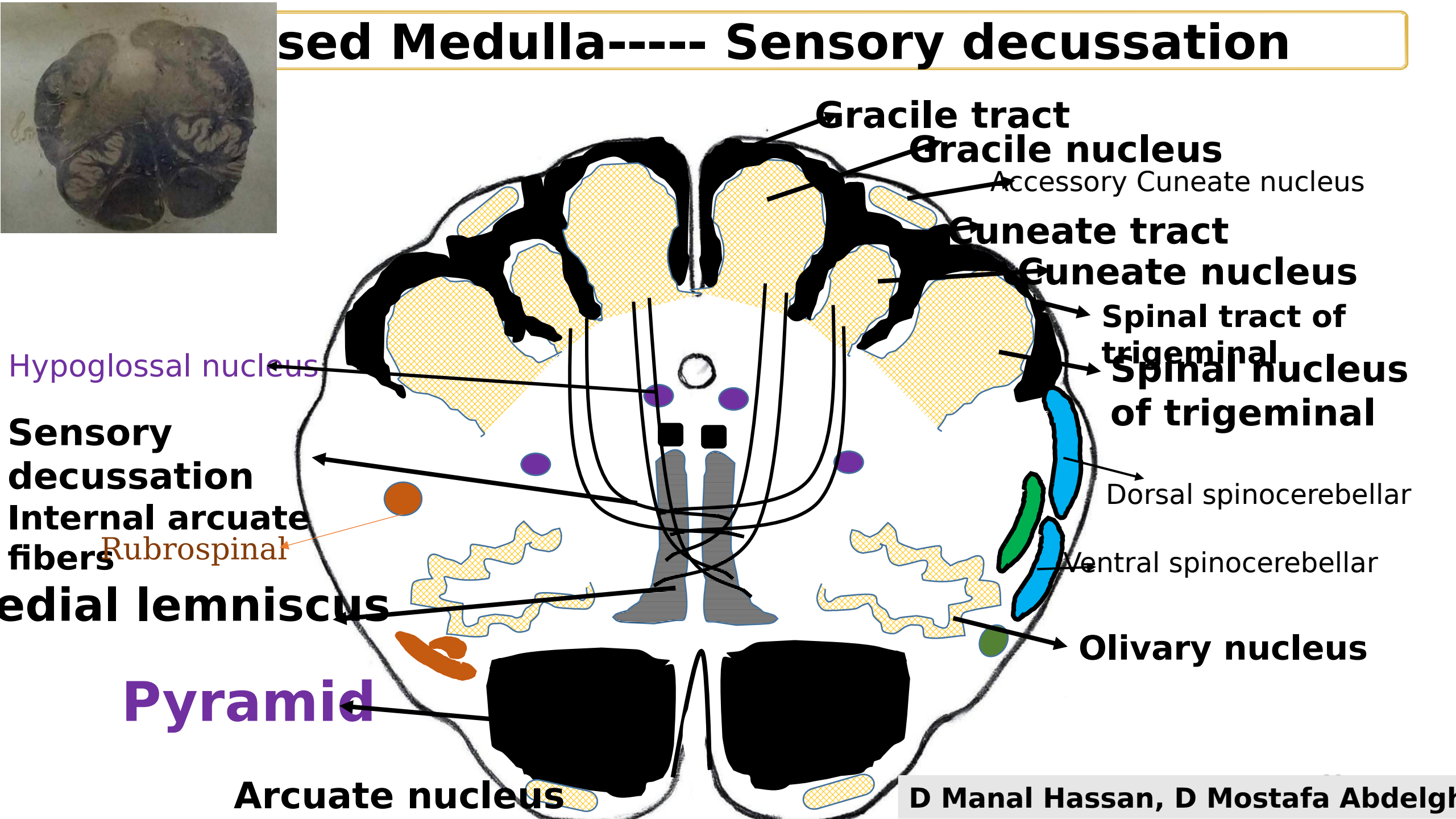


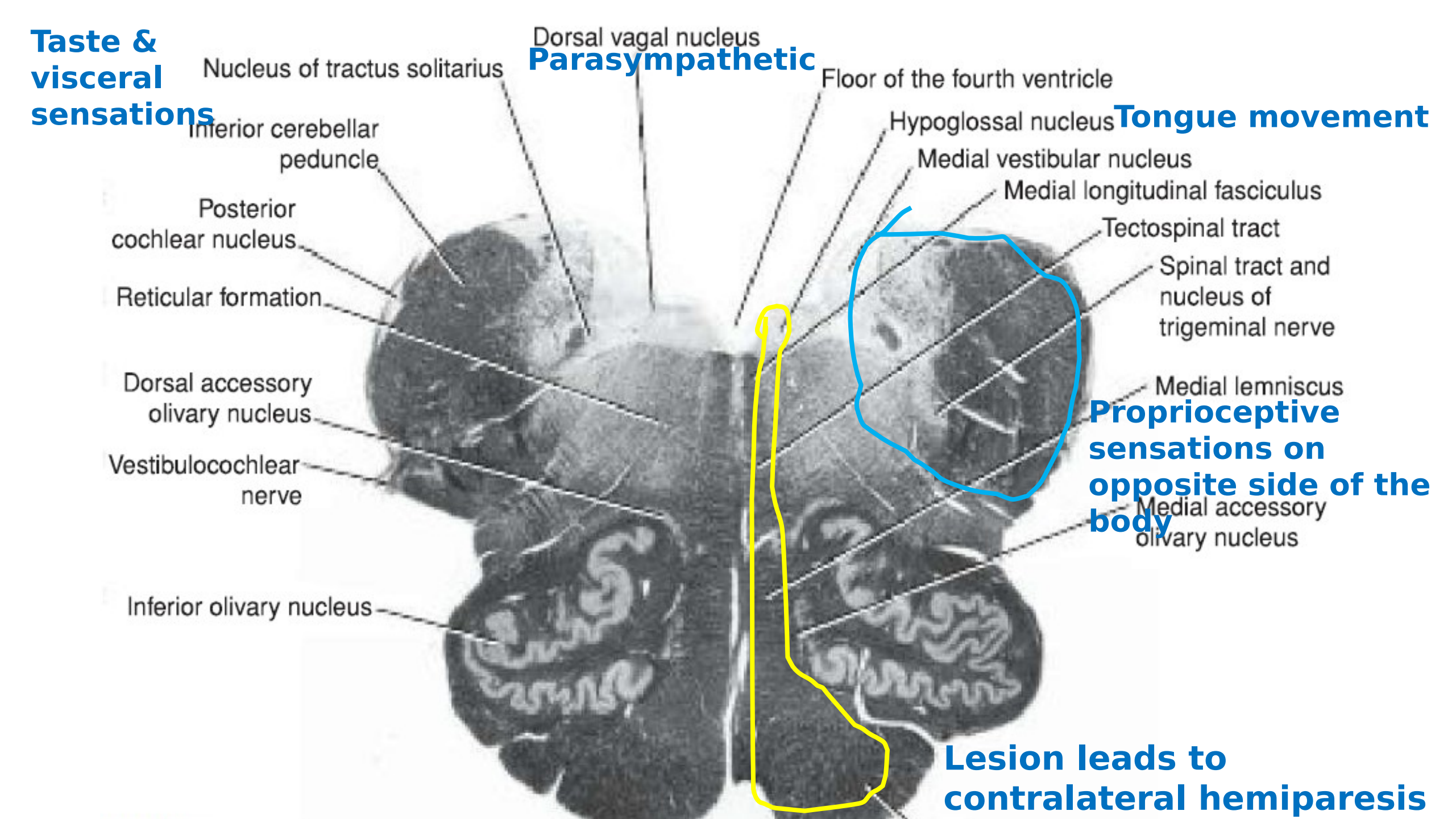
Pain & temp of face

Proprioceptive sensations on opposite side of the body

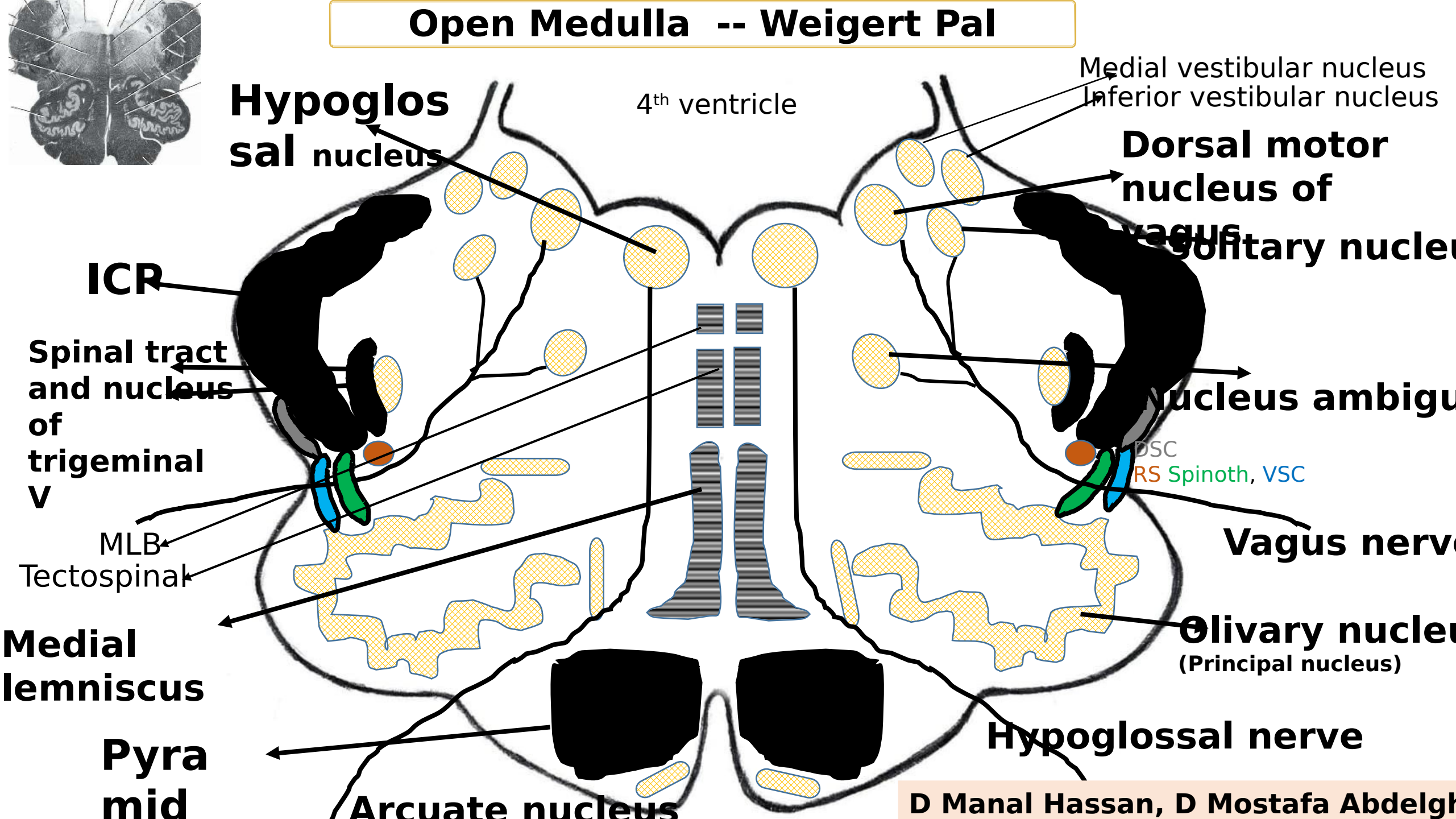
Lesion leads to contralateral hemiparesis

sed Medulla----- Sensory decussation




Taste & visceral sensations
Dorsal vagal nucleus
Parasympathetic
Nucleus of tractus solitarius
Floor of the fourth ventricle
Hypoglossal nucleus
Tongue movement
Inferior cerebellar peduncle
Medial vestibular nucleus
Medial longitudinal fasciculus
Posterior cochlear nucleus
Tectospinal tract
Spinal tract and nucleus of trigeminal nerve
Reticular formation
Dorsal accessory olivary nucleus
Medial lemniscus
Proprioceptive sensations on opposite side of the body
Vestibulocochlear nerve
Medial accessory olivary nucleus
Inferior olivary nucleus
Lesion leads to contralateral hemiparesis

Open Medulla -- Weigert Pal



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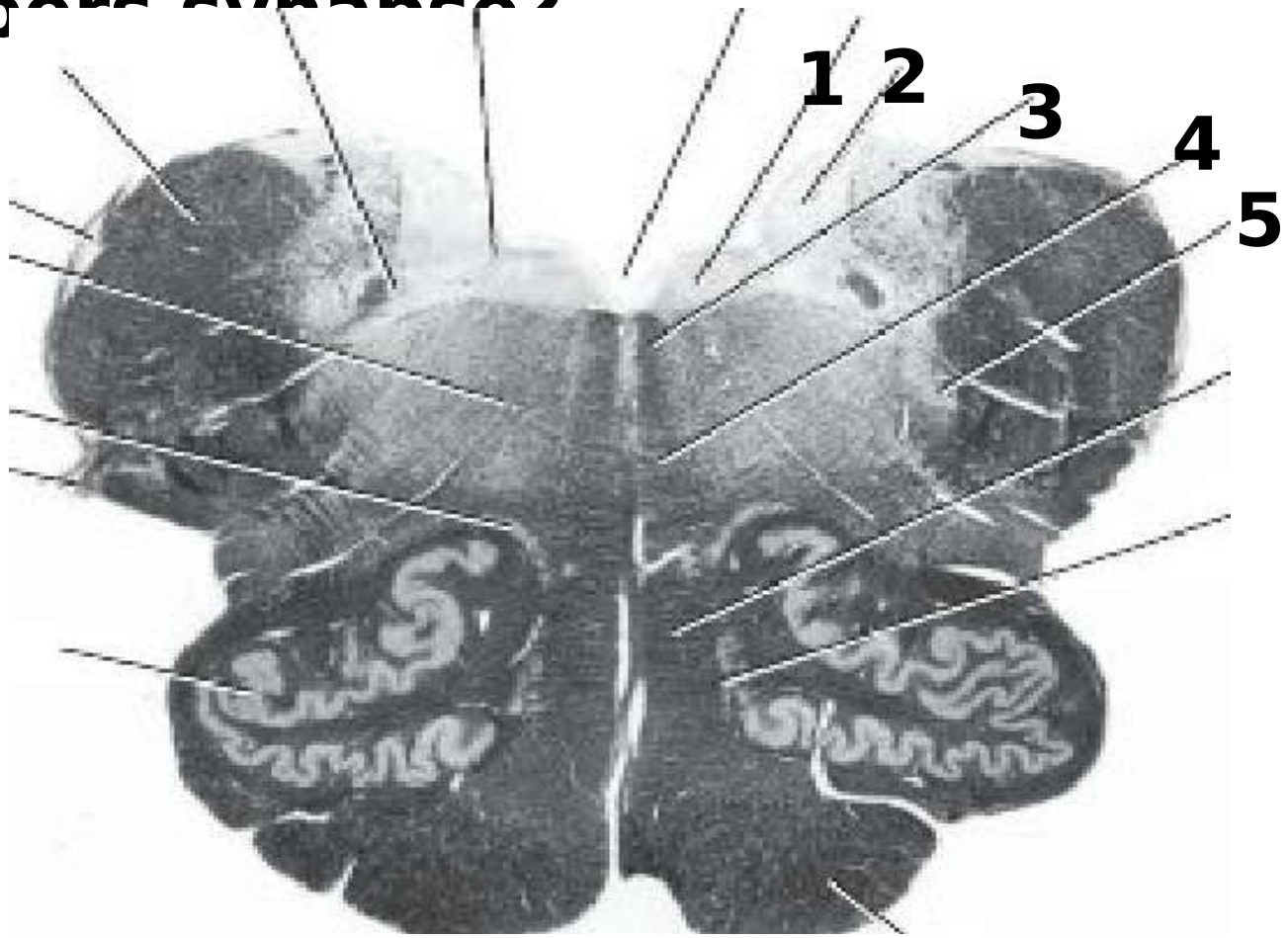
Quiz

A dentist anesthetizes a nerve in order to eliminate painful sensations that may result from a procedure to be performed on a mandibular tooth. Where do the anesthetized pain fibers synapse?

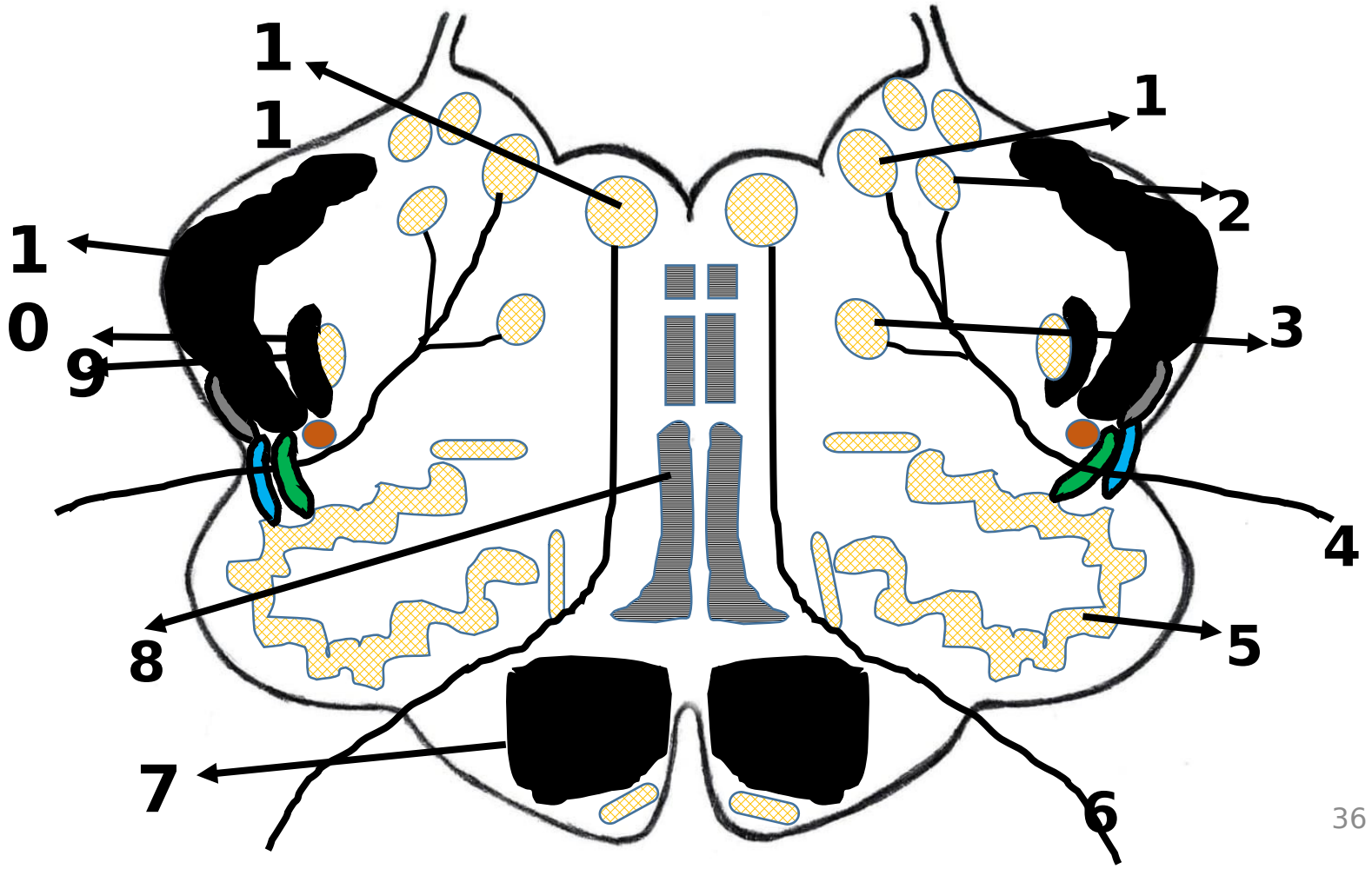
a.1
b.2
c.3
d.4
e.5



Quiz

Neurons that respond to taste sensations in the anterior 2/3 of the tongue are in which of the following locations?

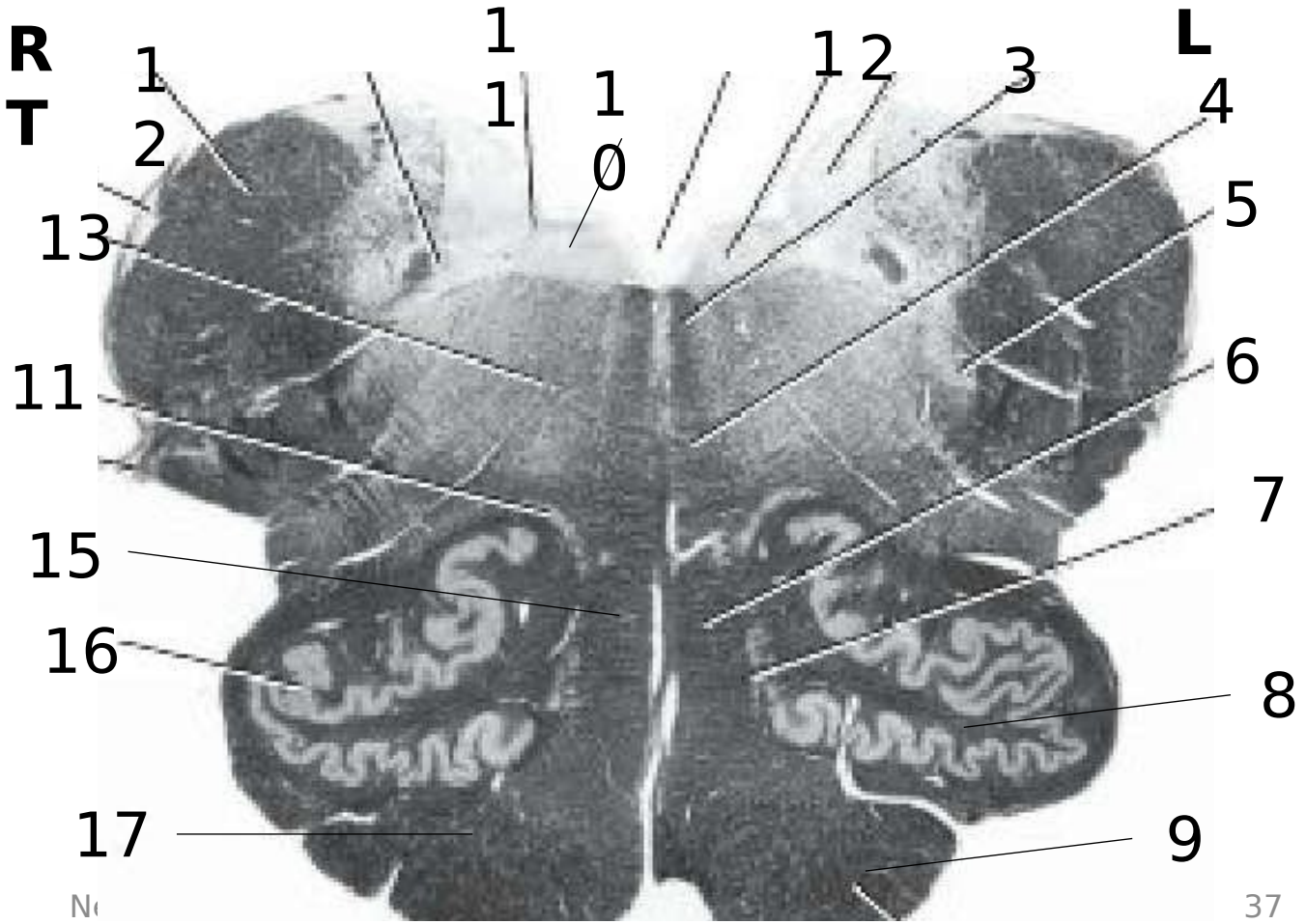
a. 1
b. 2
c. 3
d. 5
e. 11



Quiz

Which of the following tracts carry conscious proprioception from the right side of the body?

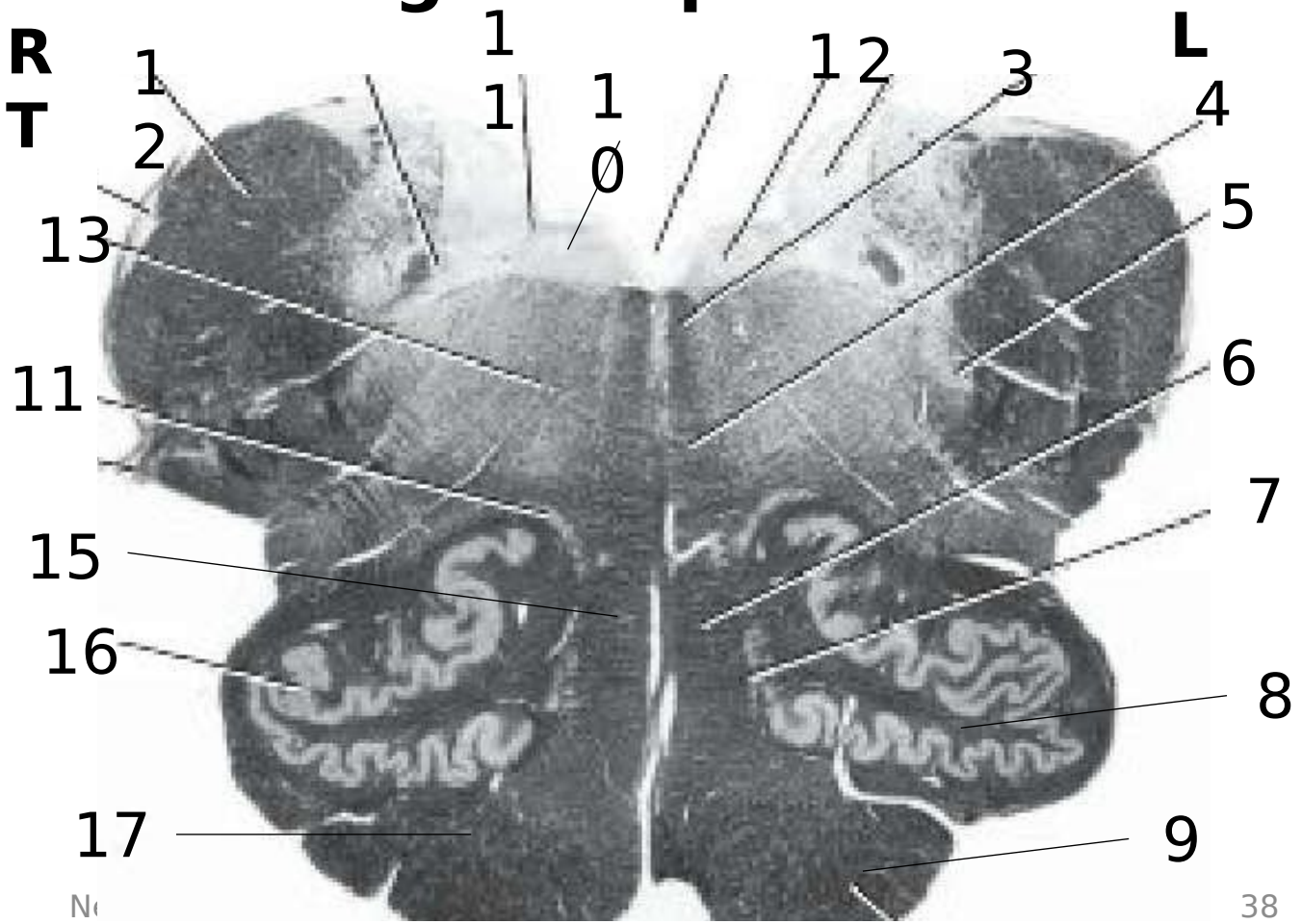
a.3
b.6
c.9
d.12
e.15



Quiz

A patient suffered deviation of the tongue to the right side after a carotid endarterectomy. Which of the following was injured during the operation?

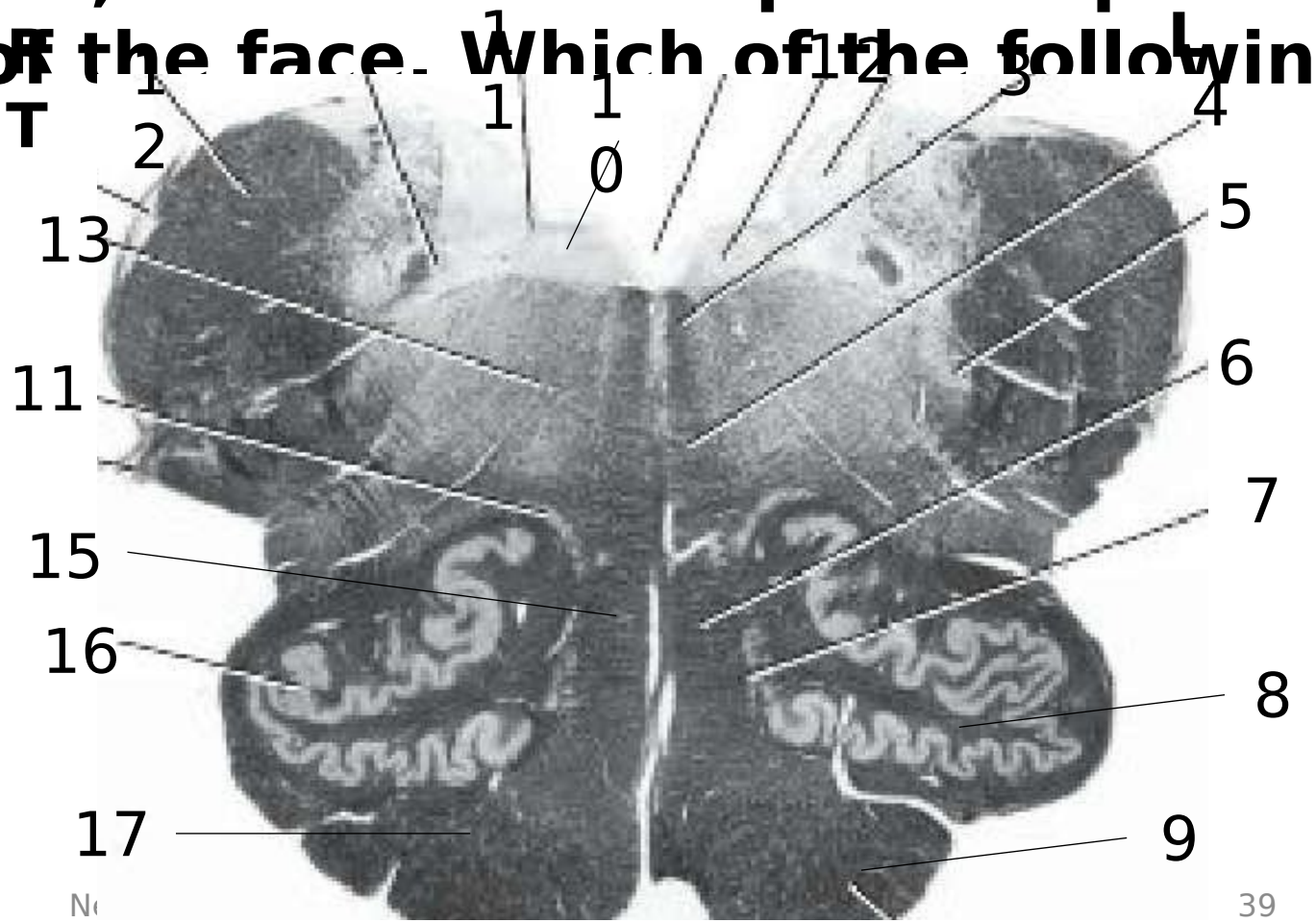
a.1
b.2
c.3
d.10
e.11



Quiz

After getting up one morning, a 64 year old man felt as if the left side of his face is burning. During the neurological examination, he failed to respond to pin pricks on the left side of the face. Which of the following is injured?

a. 1
b. 2
c. 3
d. 4
e. 5



Quiz

After suffering a stroke, a patient has right spastic hemiparesis, a loss of position and vibration sense of his right body and his tongue is deviated to the left. Which of the following is the most likely location of the lesion?

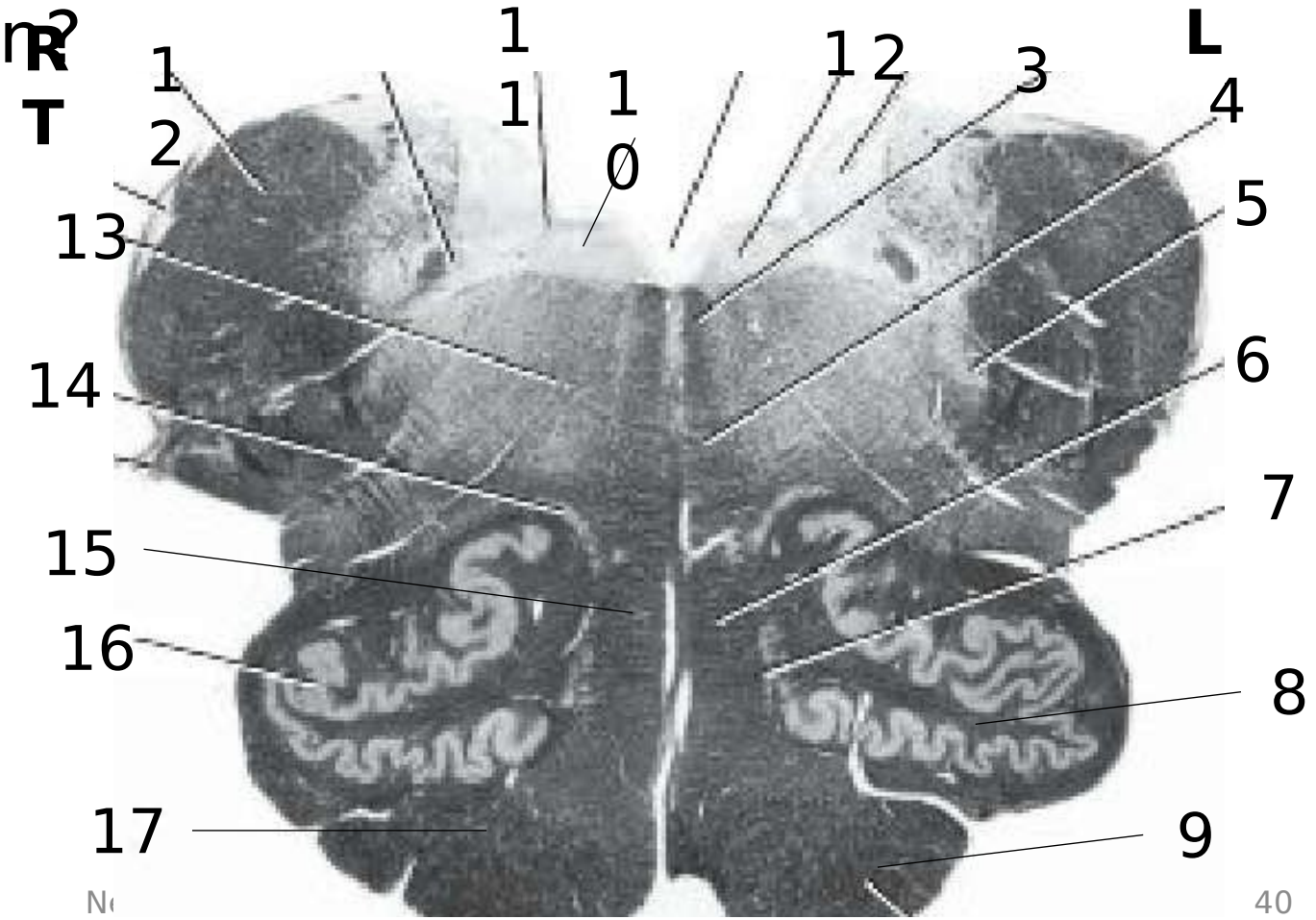
a. 1,3,7

b. 1,5,7

c. 1,6,9

d. 10,15, 17

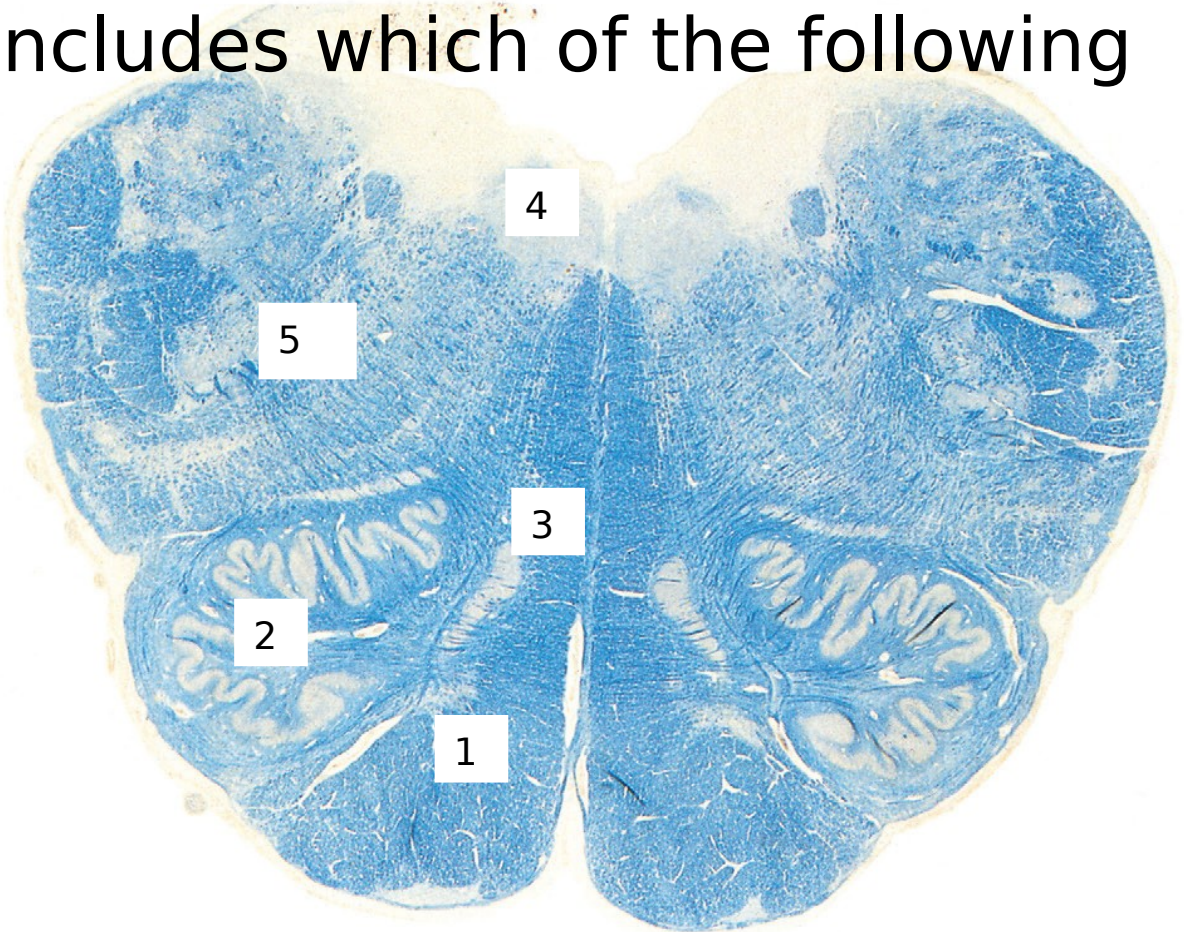
e. 10,12, 14



Quiz

A patient has hoarseness and difficulty swallowing, loss of pain and temperature sensations from the body contralateral to the lesion and from the face ipsilateral to the lesion, and Horner’s syndrome. Lesion includes which of the following areas?

a.1
b.2
c.3
d.4
e.5



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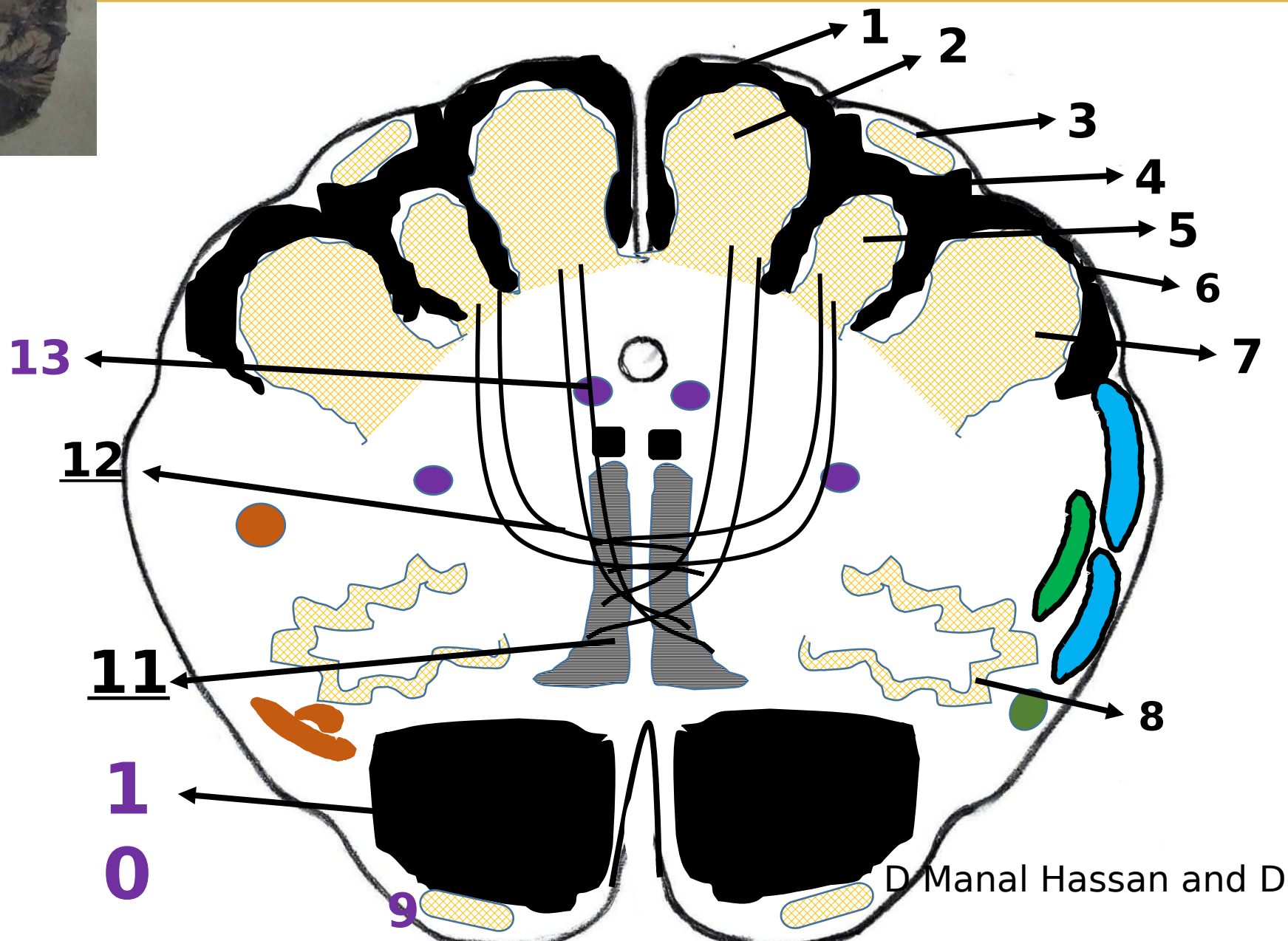

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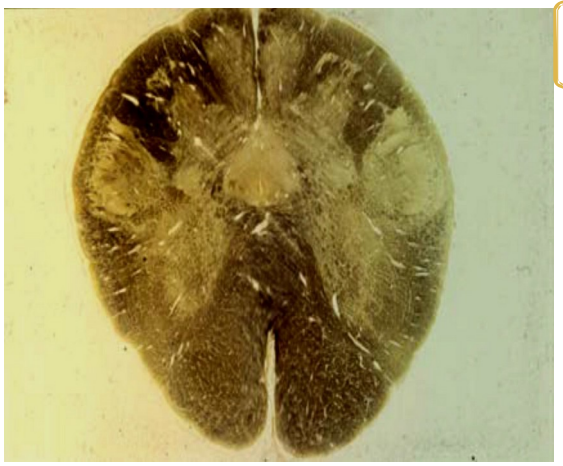

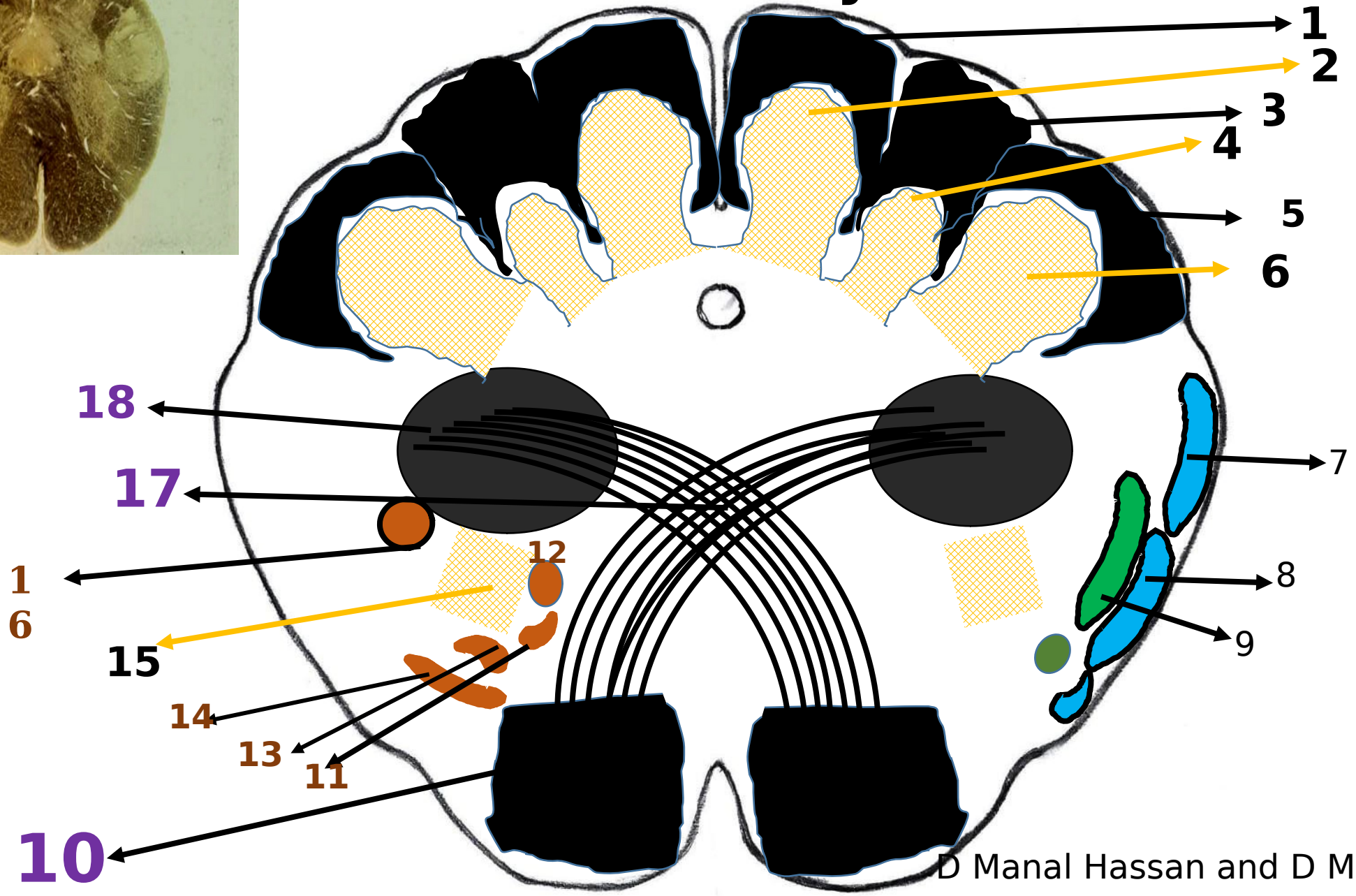

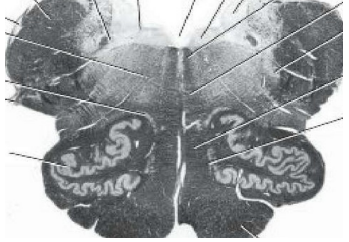

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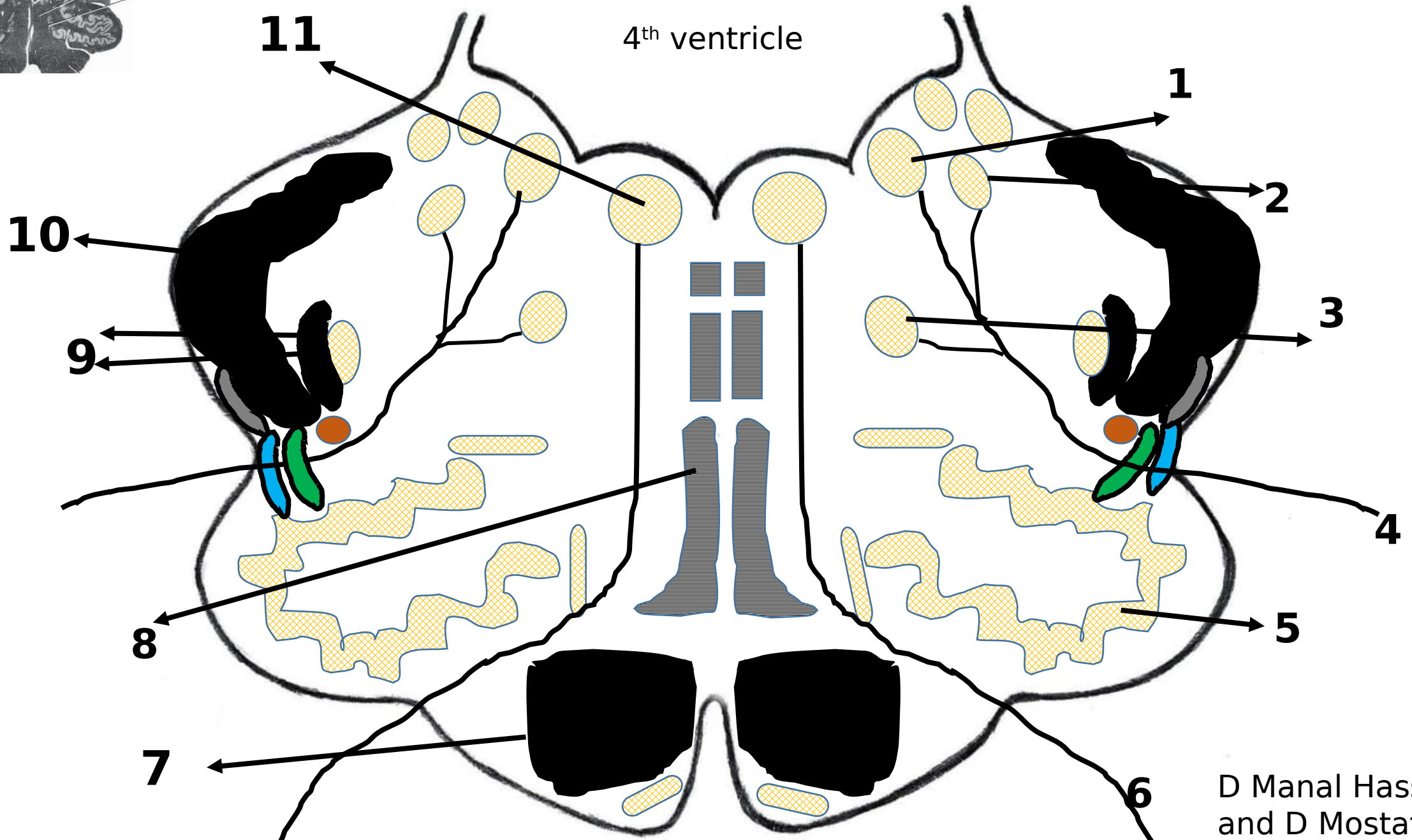


D Manal Hassan
and D Mostafa

Cerebral & Cerebellar cortex

Complete:

- **Layers of cerebellar cortex incudes ……., ……., ……:**
  1. Molecular layer
  2. Purkinje cell layer
  3. Granular layer

The molecular layer of the cerebellar cortex is formed of:

1. Outer stellate cells
2. Basket cells

The graular layer of the cerebellar cortex is formed of:

1. Granule cell
2. Golgi cells

Quiz

Which of the following cells are not found in the cerebrum?

a) Pyramidal cells.

b) Purkinje cells.

c) Granule cells.

d) Fusiform cells.

e) Cells of Martinotti

Giant cells of Betz are present in which layer of the cerebral cortex ?

a)Pleomorphic

b) External granular

c)Internal granular

d)External pyramidal.

e) Internal pyramidal.

The dendrites of Purkinje cells of the cerebellar cortex synapse with the axons of which cell?

A. Deep cerebellar nuclei

B. Golgi cells

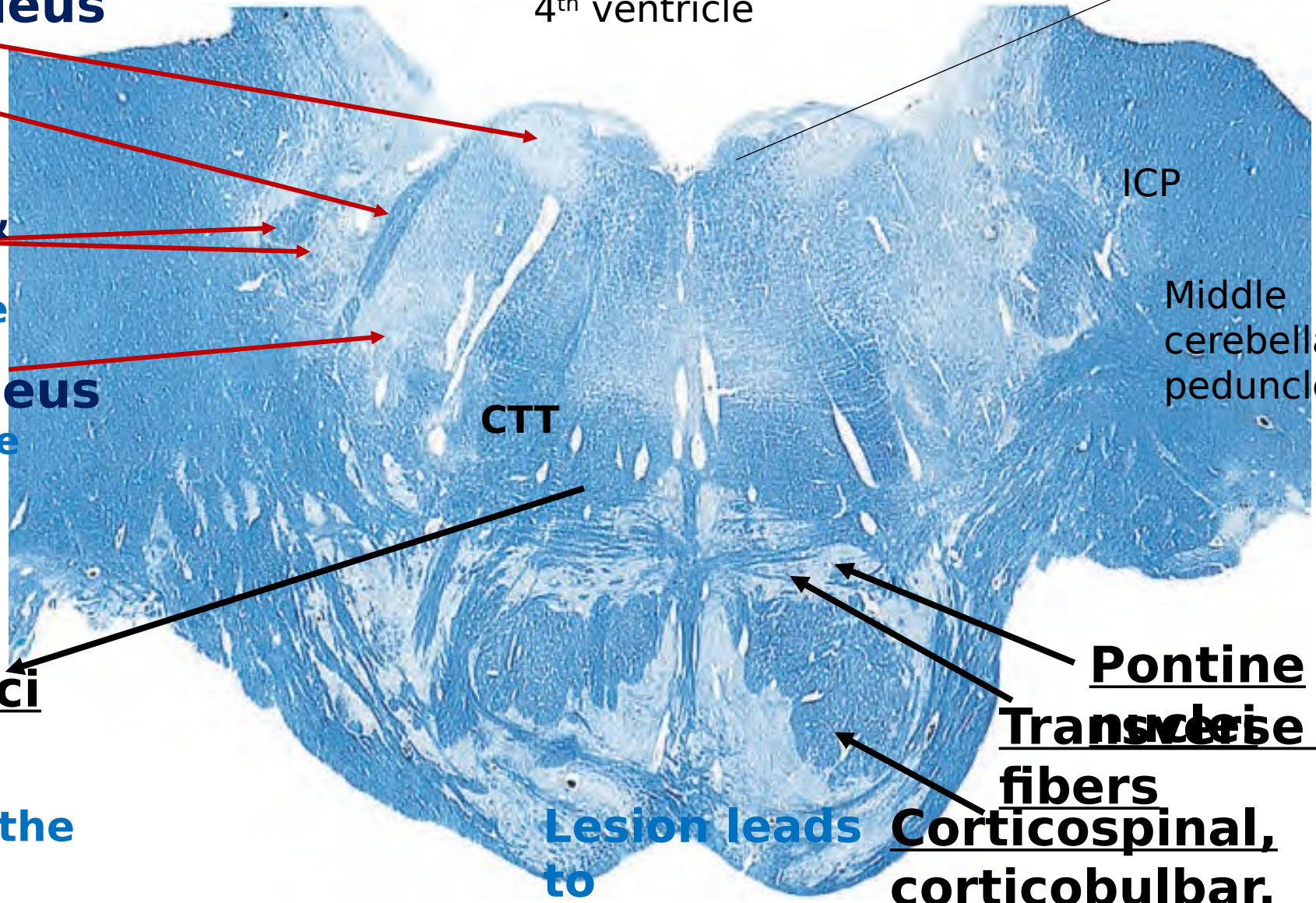
C. Pyramidal cells

D. Granule cells

Inner band of Baillarger is present in which layer of the cerebral cortex ?

a)Pleomorphic
b) External granular
c)Internal granular
d)External pyramidal.
e) Internal pyramidal.

Inferior level of Pons ---- level of facial colliculus



Lat move of eye

Abducent nucleus

Facial nerve

Spinal nucleus & tract of trigeminal

Pain&temp of face

cial motor nucleus

Ms of forehead&face

Medial lemnisci

Proprioceptive sensations on opposite side of the body

Pontine nuclei

Transverse pontine fibers

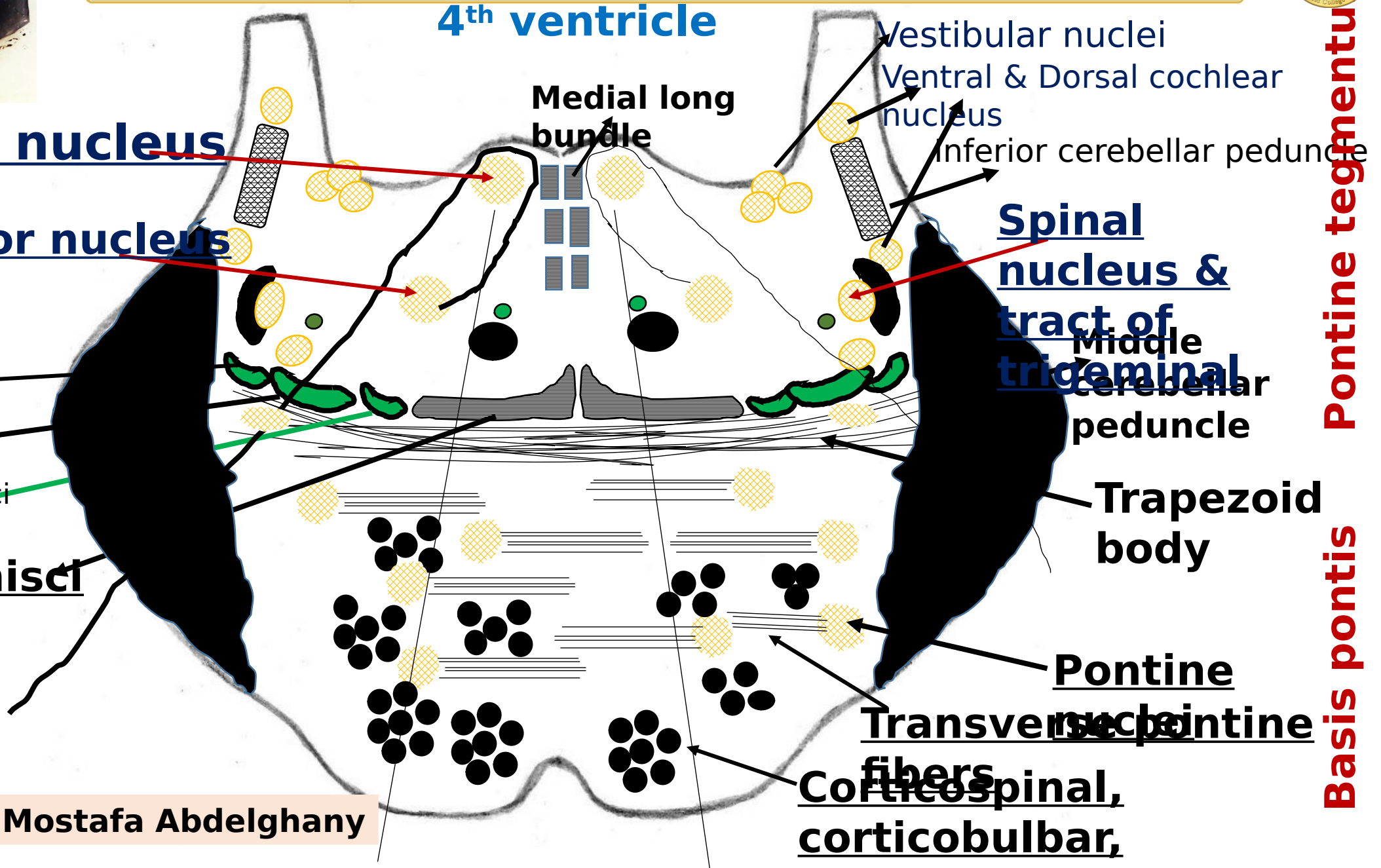
Lesion leads to

Corticospinal, corticobulbar,

Pontine tegmentum

Basis

Lower Pons at level of facial colliculus



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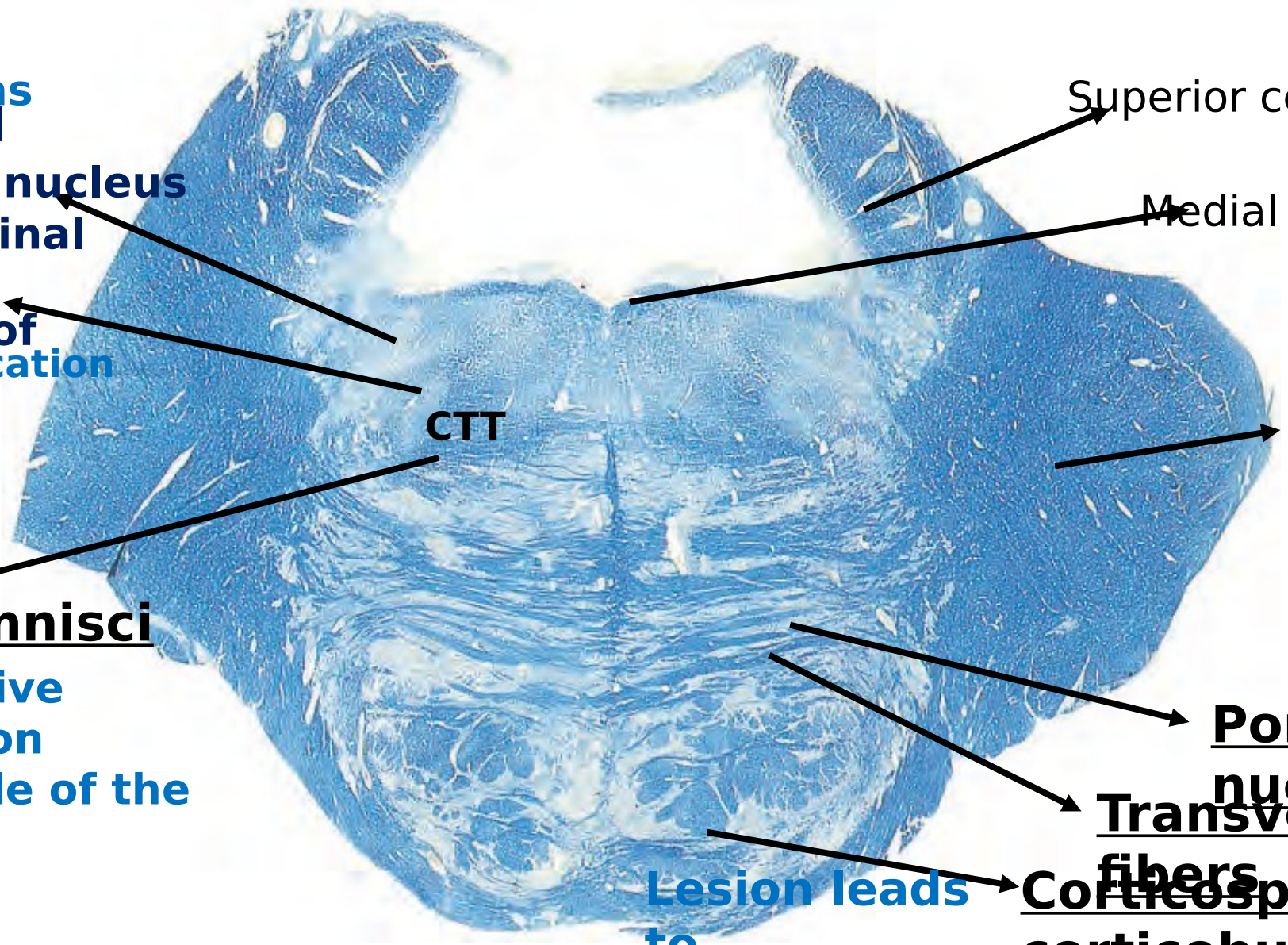
Rostral Pons at level of Trigeminal ….Weigart Pal stain



Touch sens

Principal Sensory nucleus of trigeminal

Motor nucleus of trigeminal

uscle of mustication

CTT

Medial lemnisci

Proprioceptive sensations on opposite side of the body

Superior cerebellar peduncle

Medial longitudinal bundle

Middle cerebellar peduncle

Pontine nuclei

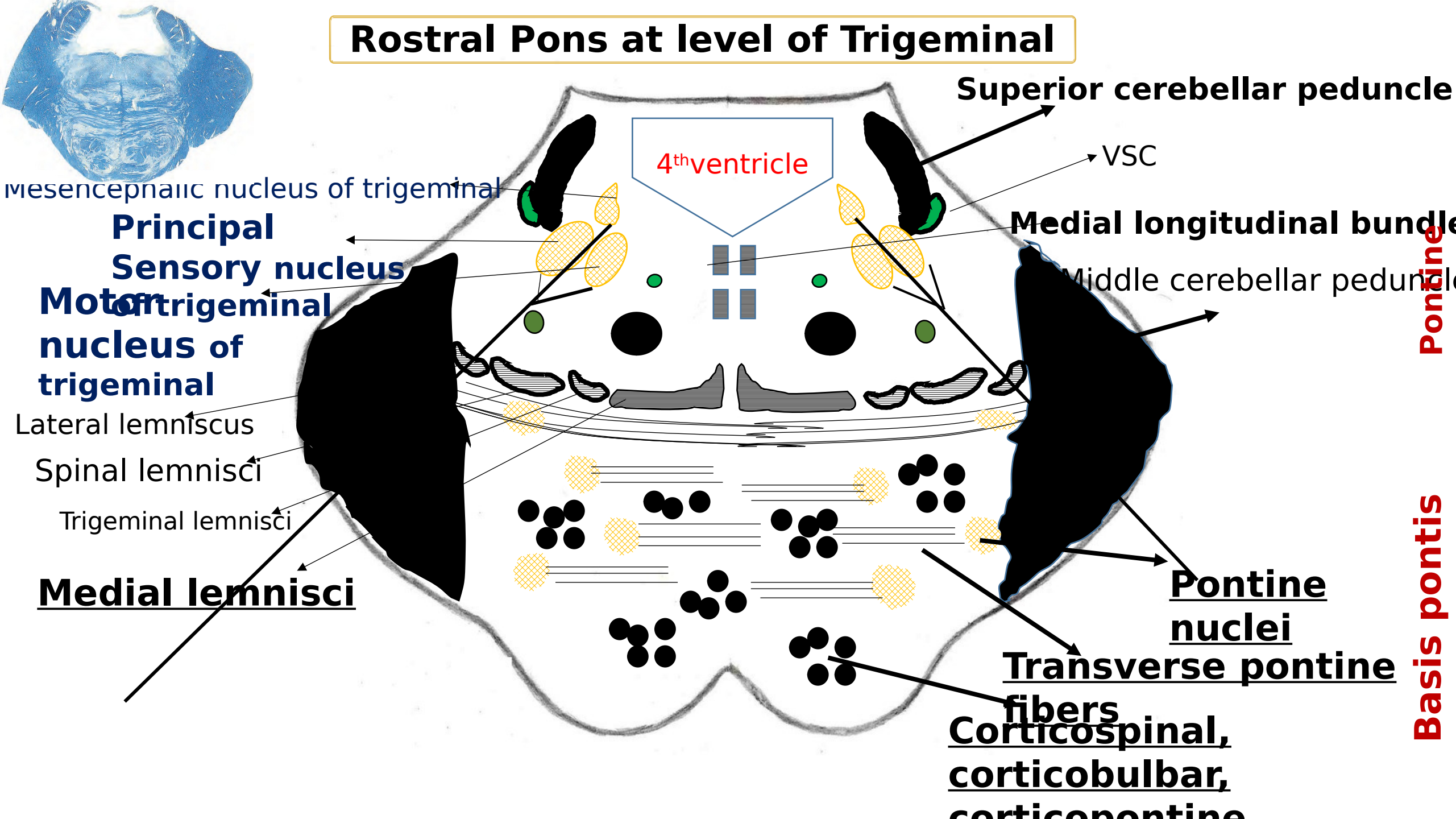
Transverse pontine fibers

Lesion leads to

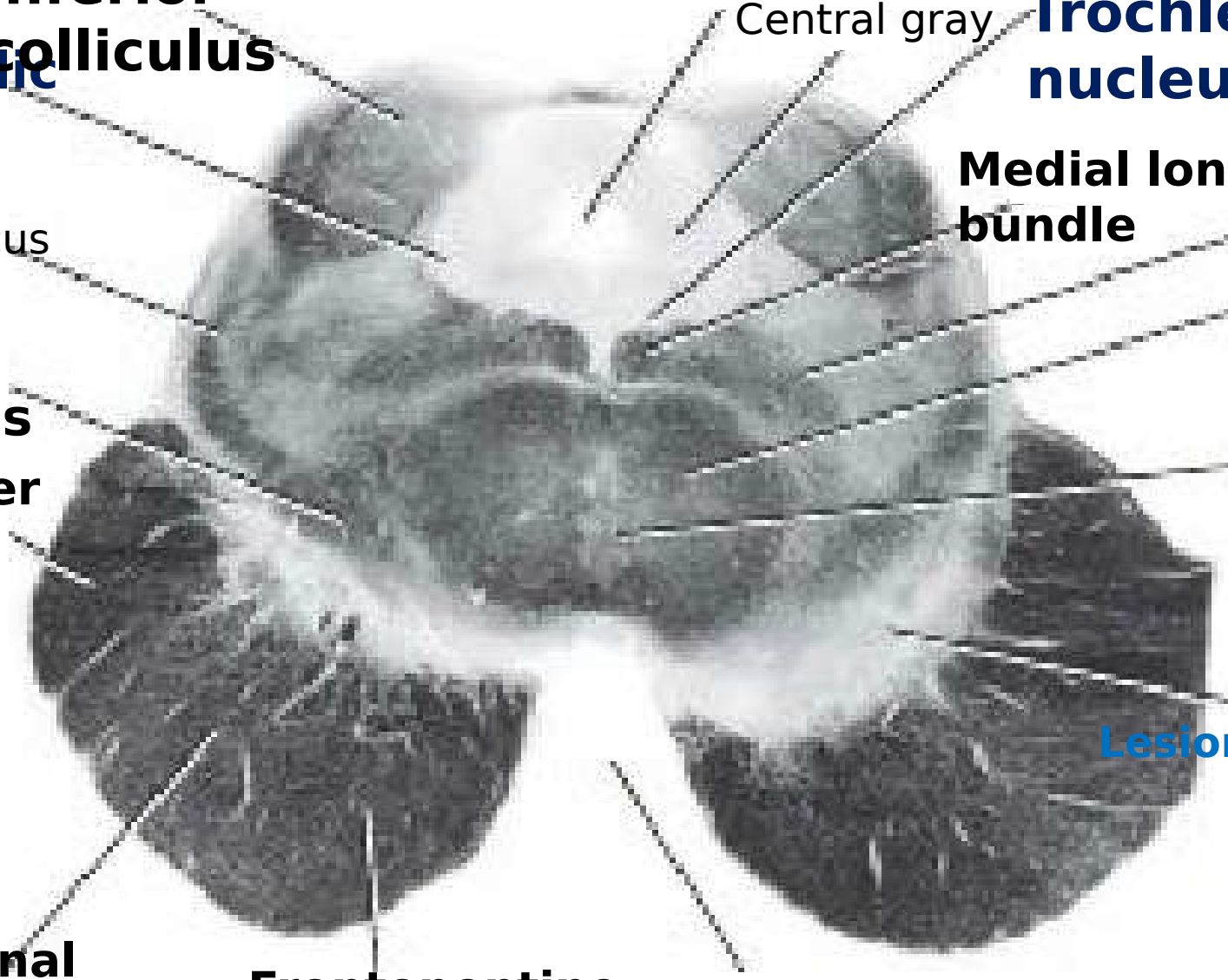
Corticospinal, corticobulbar,

Basis pontis Pontine tegmentum

Rostral Pons at level of Trigeminal



Inferior level of Midbrain ….. Weigert Pal stain



Cerebral aqueduct of Sylvius

Central gray

Inferior colliculus

Trochlear nerve nucleus

Mesencephalic nucleus of trigeminal

Lateral lemniscus

Medial longitudinal bundle

RF

Medial lemniscus

Parieto-,Tempero-, Occipto-pontine fibers

Decussation of superior cerebellar peduncle

Substantia nigra

Lesion leads to Parkinsonism

Tectum

Tegmentum

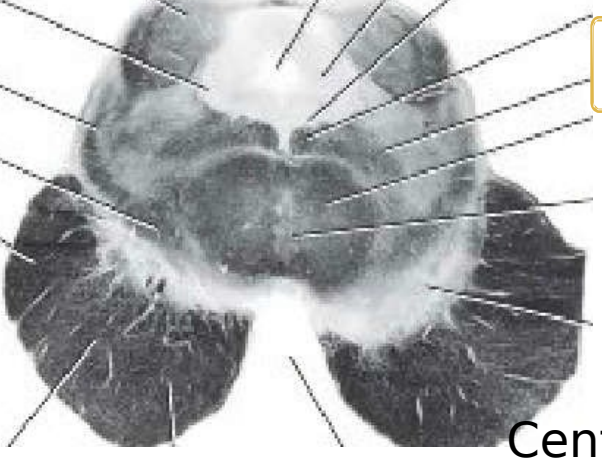
Crus cerebri

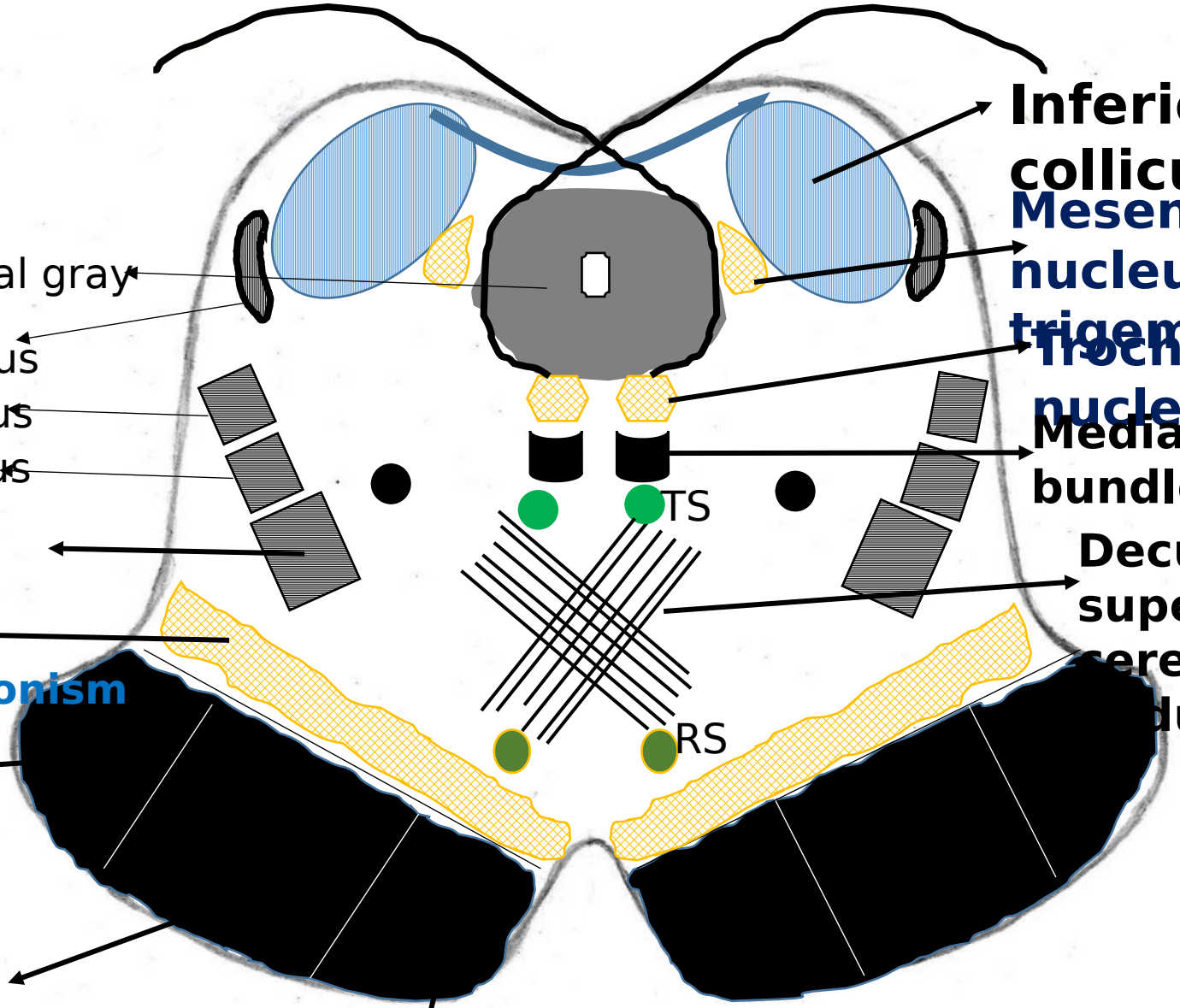
Corticospinal fibers

Frontopontine fibers

Lesion leads to contralateral

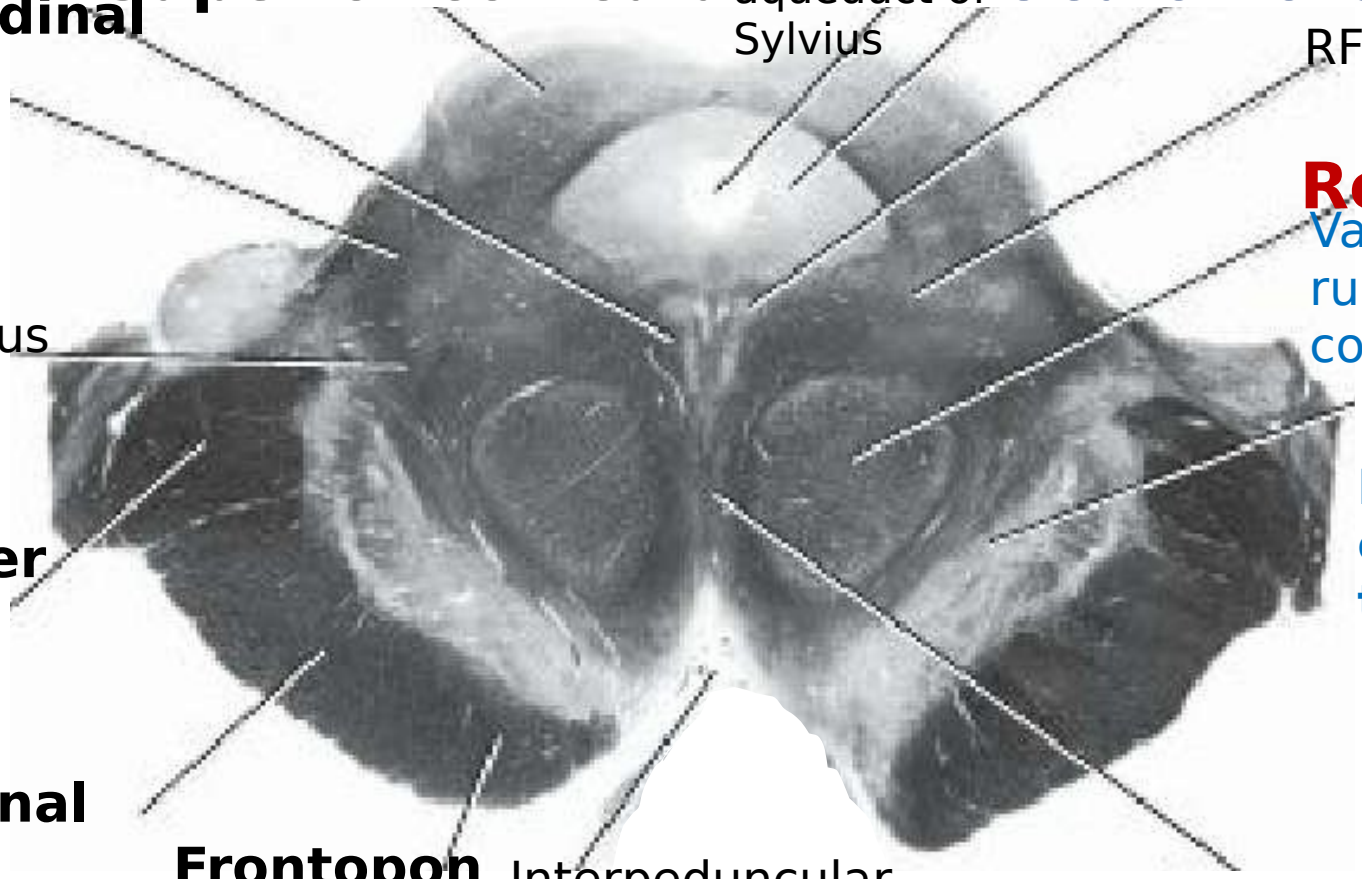
Inferior level of Midbrain





D Manal Hassan, D Mostafa Abdelghar

Superior level of Midbrain



Lesion leads to dilated pupil

Superior colliculus

Cerebral aqueduct of Sylvius

Oculomotor nucleus

RF

Medial longitudinal bundle

Red nucleus

Vascular gives rubrospinal tract, control ms tone

Medial Lemniscus

Substantia nigra

Pigmented cellsLesion leads to Parkinsonism

Parieto-,Tempero-, Occipto-pontine fibers

Corticospinal fibers

Corticobulbar fibers

Frontopontine fibers

Interpeduncular fossa

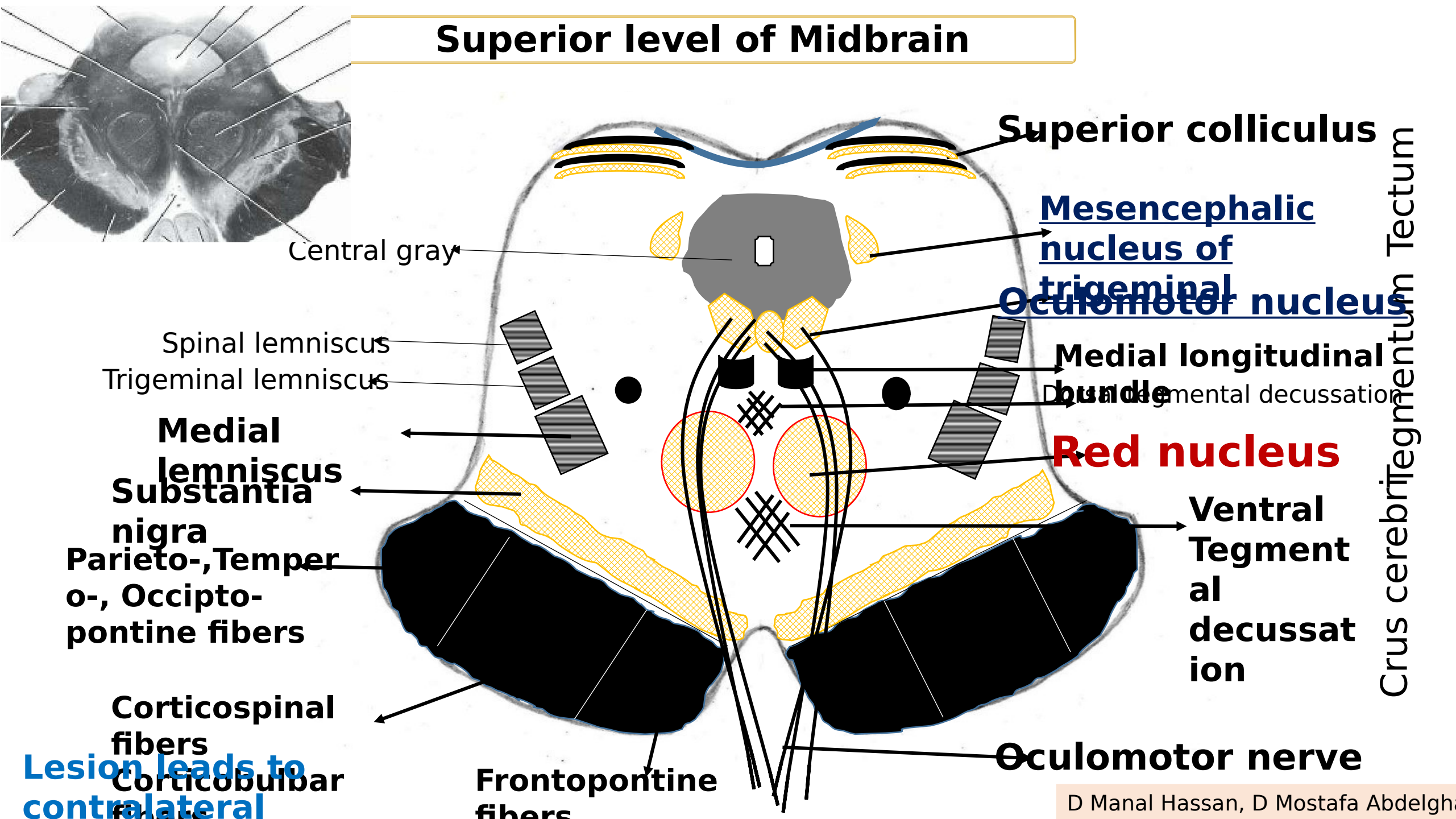
Lesion leads to contralateral

Tectum

Tegmentum

Crus cerebri

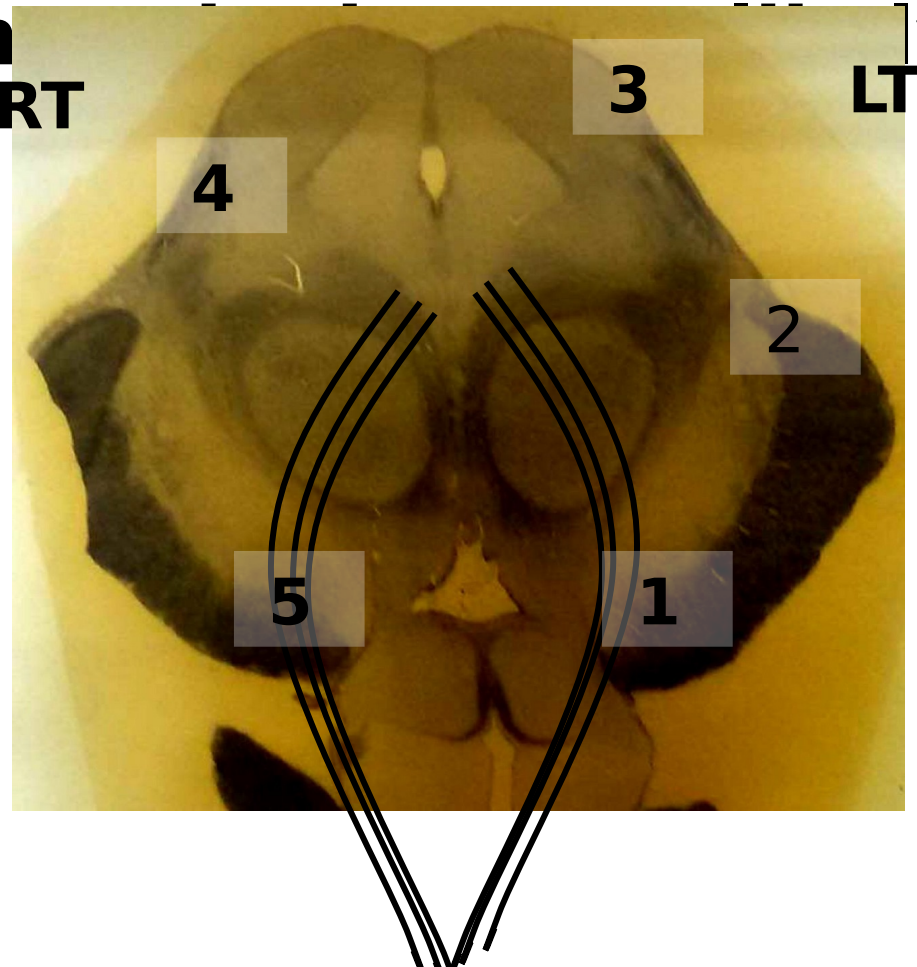
Superior level of Midbrain



Lesion leads to contralateral

Quiz

A patient presents with left sided hemiparesis and a left sided weakness of the left lower face. He also has a dilated right pupil, an abducted and depressed right eye. Wh[illegible]y location of the lesion?

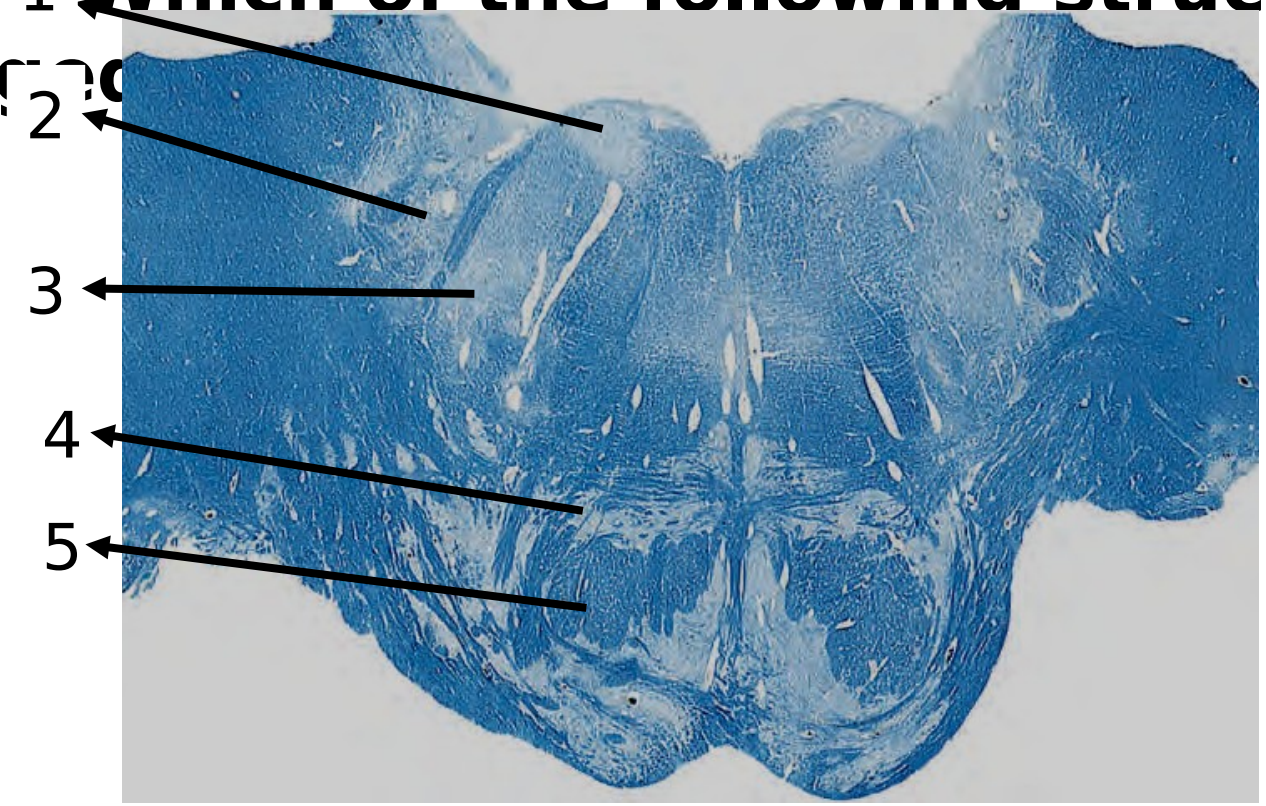


a. 1
b. 2
c. 3
d. 4
e. 5

Quiz

A 35-year-old man is brought to the emergency room after a motor-cycle collision that cracked his helmet. When the man regained consciousness, a full neurological examination showed that he cannot abduct his right eye. Which of the following structures is most likely damaged?

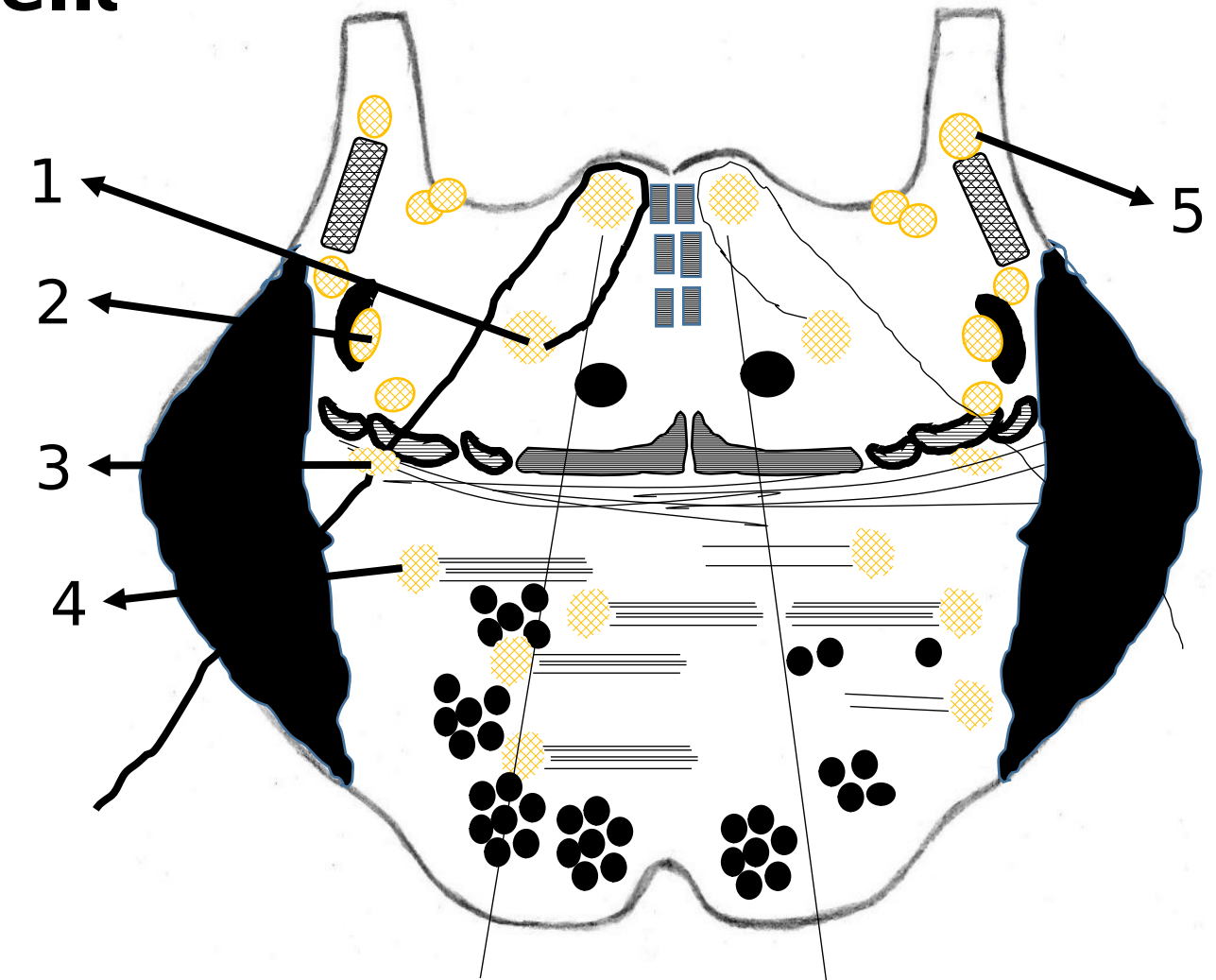
a. 1
b. 2
c. 3
d. 4
e. 5



Quiz

Which of the following structures send fibers through the middle cerebellar peduncle?

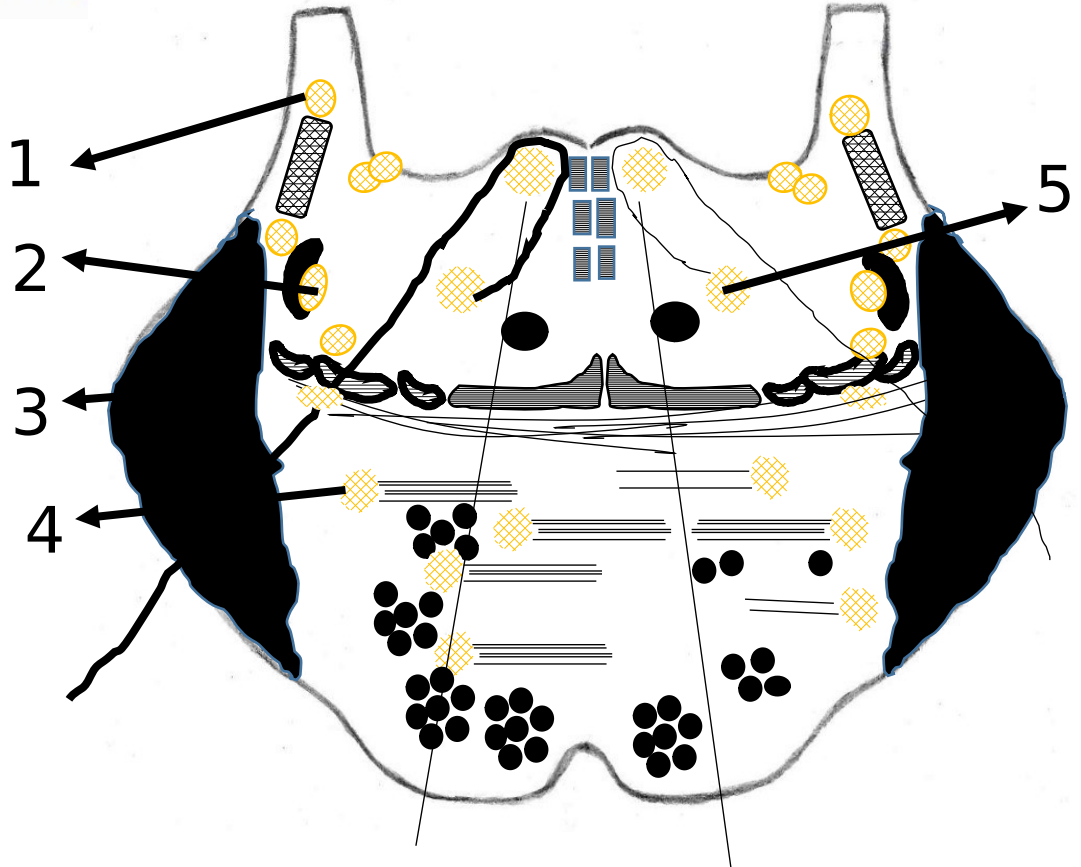
a. 1
b. 2
c. 3
d. 4
e. 5



Quiz

A 50-year-old man complains to a physician that he can no longer hear phone conversations with his right ear. The problem has developed over the last 3 years. A hearing test demonstrates a marked unilateral sensorineural hearing loss at all frequencies in the right ear. The left ear has normal hearing. Which of the following is the most likely site of the lesion causing this man's problem?

a. 1
b. 2
c. 3
d. 4
e. 5



Quiz

A 72-year-old man begins to notice resistance when he tries to raise his arms. He walks with a stooped posture and his feet barely leave the floor when he walks. He seems to lack facial expression and has difficulty swallowing. A slight tremor is evident in his hands when he is sitting down. In which of the following areas would degenerating neuronal cell bodies most likely be found in this patient?

- A. Substantia nigra
- B. Motor cortex
- C. Spinal cord
- D. Striatum
- E. Thalamus

Quiz

A 72-year-old man begins to notice resistance when he tries to raise his arms. He walks with a stooped posture and his feet barely leave the floor when he walks. He seems to lack facial expression and has difficulty swallowing. A slight tremor is evident in his hands when he is sitting down. In which of the following areas would degenerating neuronal cell bodies most likely be found in this patient?

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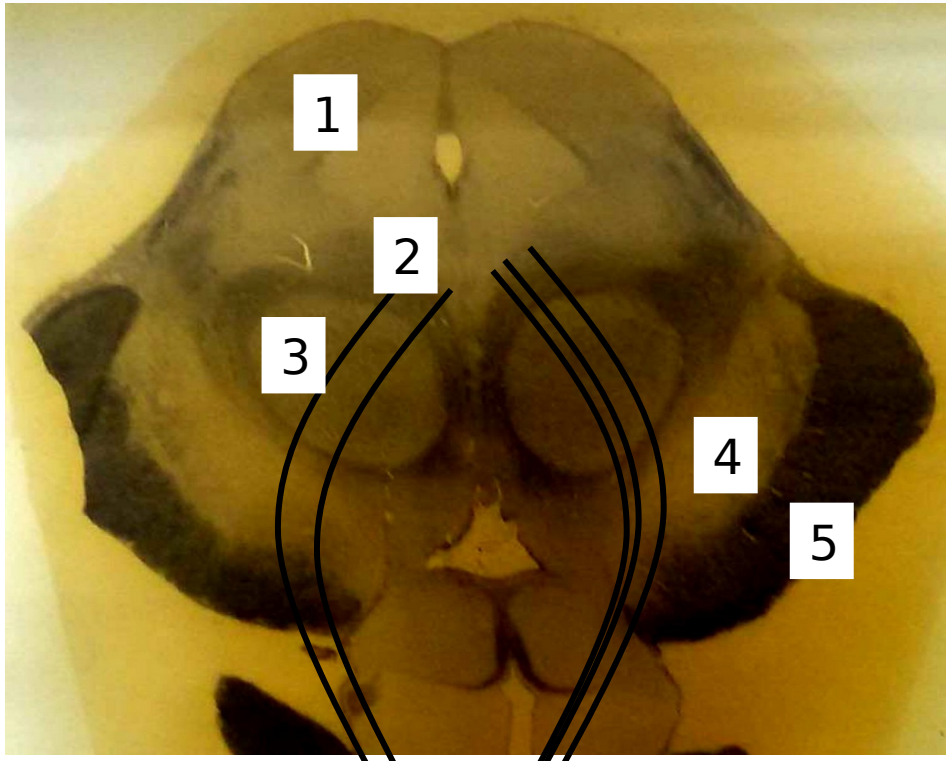
d. 4
e. 5



Quiz

A 45-year-old businessman suffers a stroke. He has a spastic hemiparesis on the right, as well as a dilated pupil and exotropia on the left. Chewing and swallowing are normal, but the patient has difficulty keeping liquids inside his mouth on the right. A lesion in which of the following locations could account for all of this patient's symptoms?

- A. Caudal pons
- B. Medulla
- C. Midbrain
- D. Precentral gyrus
- E. Rostral pons

Quiz

A 50-year-old man complains to a physician that he can no longer hear phone conversations with his right ear. The problem has developed over the last 3 years. A hearing test demonstrates a marked unilateral sensorineural hearing loss at all frequencies in the right ear. The left ear has normal hearing. Which of the following is the most likely site of the lesion causing this man's problem?

A. Cochlear nucleus

B. Inferior colliculus

C. Medial geniculate nucleus

D. Middle ear

E. Primary auditory cortex

Quiz

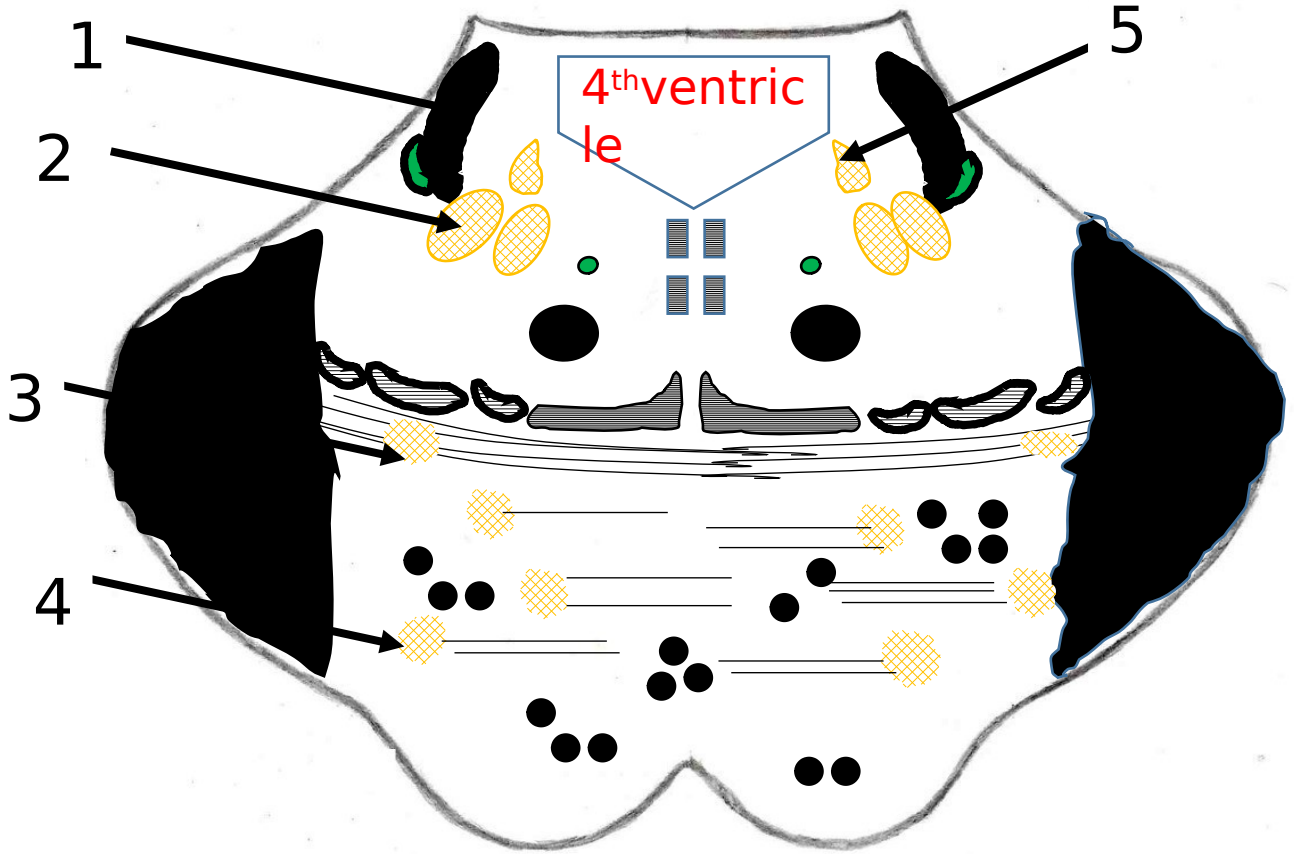
Neurological examination shows loss of touch sensation on one side of a patient's face. These sensory fibers from the face project into which nucleus of the brain stem?

- A. Principal (main)
- B. Mesencephalic
- C. Solitary
- D. Spinal trigeminal
- E. Ambiguus

Quiz

Neurological examination shows loss of touch sensation on one side of a patient's face. These sensory fibers from the face project into which nucleus of the brain stem?

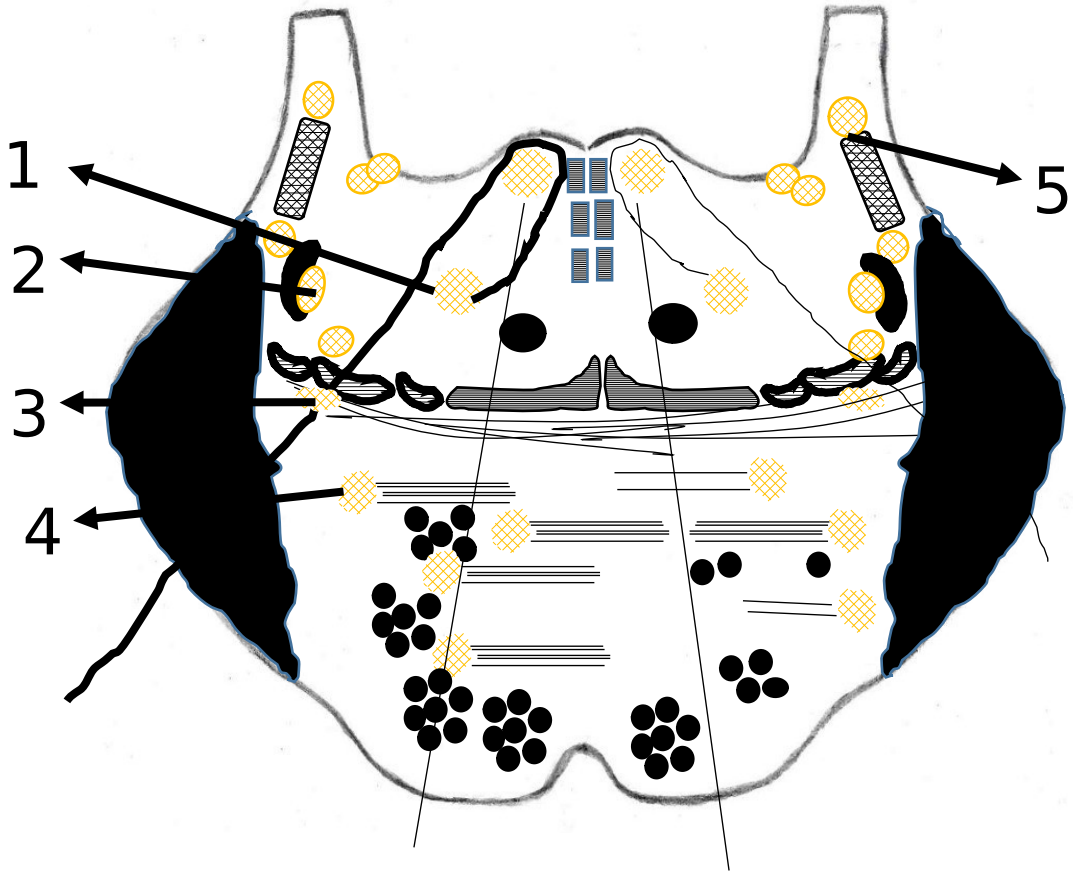
a. 1
b. 2
c. 3
d. 4
e. 5



Quiz

Neurological examination of a 50-year-old woman showed that she cannot wrinkle her forehead and cannot close her right eye. Which of the following is most likely the location of the lesion?

a. 1
b. 2
c. 3
d. 4
e. 5



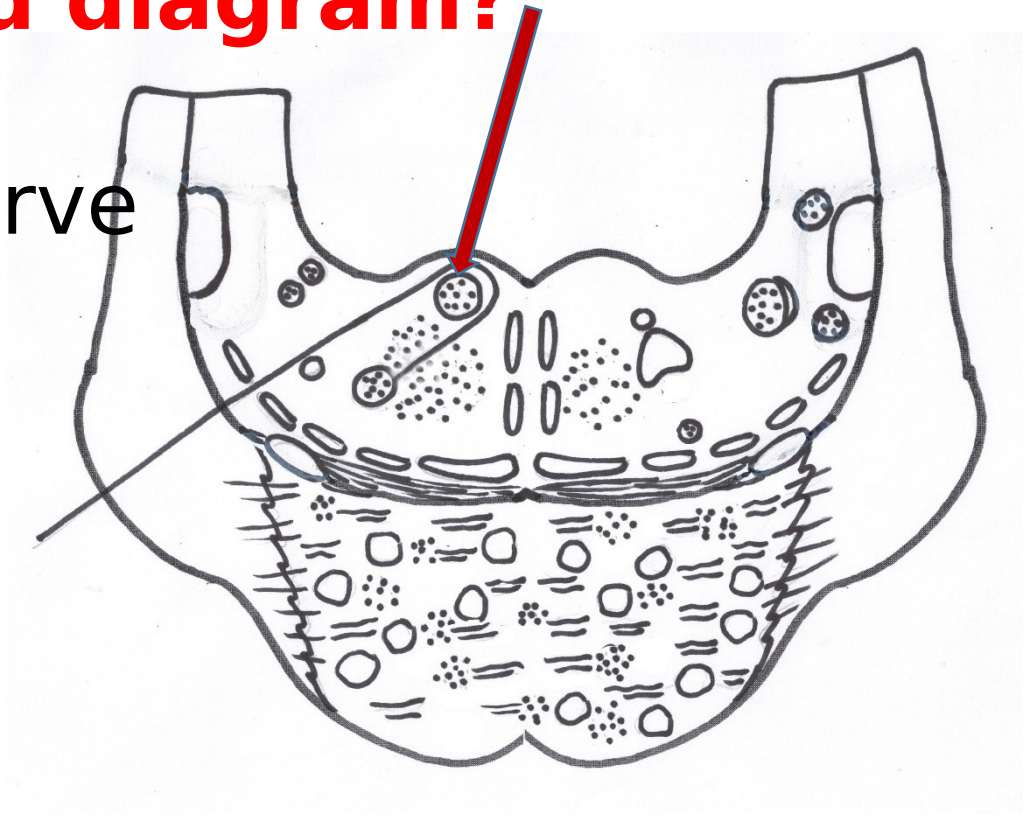
Quiz

- **The following important structures are located in which level of the brainstem ?**

1. The red nucleus lies within the superior level of midbrain.
2. The facial colliculus lies in the superior level of the pons.
3. The motor nucleus of the trigeminal nerve lies in the inferior pons.
4. The abducens nucleus lies within the superior level of the pons.

Quiz

- **Which of the following structure is indicated by the arrow in the provided diagram?**



1. Spinal nucleus of trigeminal nerve
2. Abducent nucleus
3. Facial nucleus
4. Lateral vestibular nucleus
5. Dorsal cochlear nucleus

Quiz

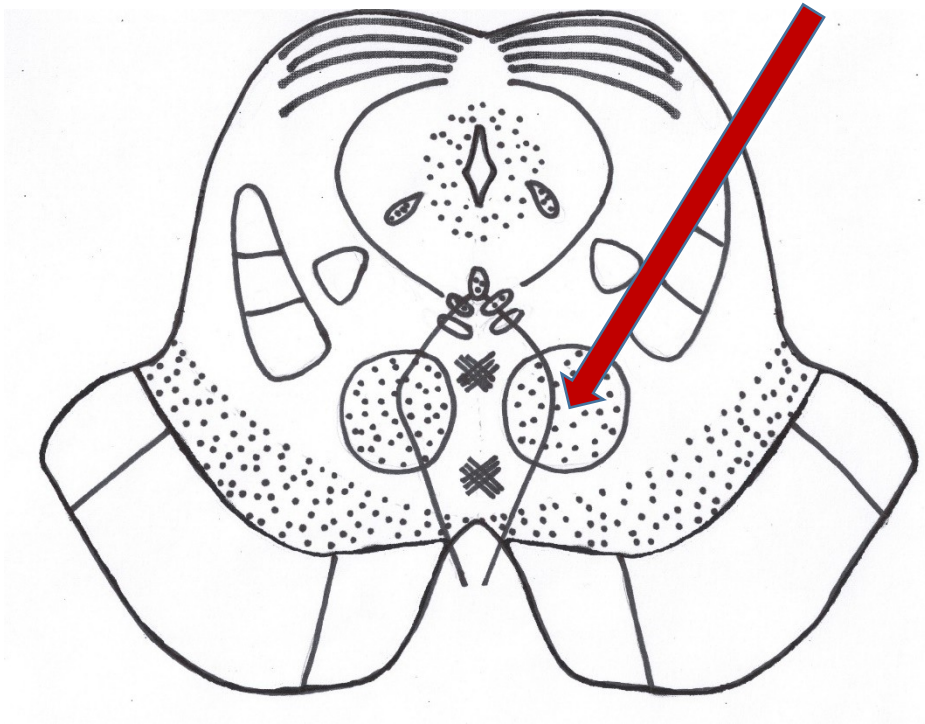
- **Which of the following statement is correct concerning a transverse section through the inferior level of pons?**

A. The facial colliculus is formed by roots of 7th nerve around 5th nucleus
B. The vestibulocochlear nerve emerges near midline of basis pontis.
C. The pontine nuclei lie between the transverse pontine fibers.
D. Cortico-pontine fibers pass through ICP.
E. The medial lemniscus with its long axis lies vertically

Quiz

- **Which of the following structure is indicated by the arrow in the provided diagram?**

1. Mesencephalic nucleus of trige
2. Oculomotor nerve nuclei
3. Red nucleus
4. Superior colliculus nuclei
5. Substantia nigra nuclei



Quiz

- **Which of the following statement is correct concerning a transverse section through the superior level of midbrain?**

1. Corticospinal fibers pass via lateral third of the crus cerebri.
2. The oculomotor nerve traverses the red nucleus.
3. The trochlear nerve emerges on the interpeduncular fossa.
4. The superior colliculi present in the tegmentum of midbrain.
5. The central gray matter encircles the red nuclei